Business Roundtable

Resilient, Diverse and Secure: Improving Critical Supply Chains

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Overview

Building resilient, diverse and secure supply chains is vital to U.S. national security and the competitiveness of U.S. companies and workers, especially for materials that underpin critical technologies. In recent years, U.S. policymakers have focused on China's role in certain global supply chains, noting that the United States needs to guard against overreliance on a single source, especially in the context of the U.S.-China competitive landscape and continuing political and geopolitical risk. One in four U.S. and European Union (EU) firms are either considering or have begun actively moving parts of their manufacturing and sourcing activities out of China.[1, 2]

This report examines the interdependencies in strategically significant supply chains and makes recommendations for improving resiliency both overall and within five identified **critical supply chains:**

- **Critical Minerals and Materials**
- **Synthetic Active Pharmaceutical Ingredients (APIs)**
- **Agrochemicals (e.g., crop protection)**
- **Printed Circuit Boards (PCBs) and Printed Circuit Board Assembly (PCBA)**
- **Foundational Semiconductors**

This report includes several recommendations for policies that are cross-cutting strategic enablers of resiliency **across supply chains:**

— **Trade:** Deepen economic integration through trade and investment agreements with priority partners that can serve as alternative sources for critical inputs, alternative platforms for manufacturing and processing, and alternative markets for U.S. goods and services in the face of geopolitical risk.

— **Tax:** Maintain a competitive tax code in the United States that ensures businesses continue prioritizing the United States as the primary location to create jobs.

— **Workforce:** Modernize the public workforce development system to ensure investments are preparing workers for in-demand careers, expanding economic opportunity for all Americans and complementing businesses' efforts to build a world-class, "ever-ready" U.S. workforce.

— **Regulation:** Streamline regulatory frameworks and permitting processes for critical supply chains to expedite market entry, foster innovation and promote resiliency.

At the same time, each identified critical supply chain has unique attributes and concentration risks. Mitigating these risks will require a more targeted approach through tailored public policies, which in turn will strengthen resilience and promote growth. These supply chain-specific policy recommendations are outlined in greater detail in the second half of this report.

Introduction

U.S.-China Relationship

For nearly 30 years, China has been a global center for manufacturing and supply chain sourcing. China represented 18% of global GDP in 2022, but its weight in manufacturing value added was nearly double that at 32%.[3,4] The United States imports more goods, in terms of total value, than any other country in the world.[5] In 2023, imports from China accounted for $450 billion of total U.S. imports of $3.2 trillion.

China has significant dependencies on the United States as well. China directly imported about $180 billion worth of goods from the United States in 2022 — roughly 7% of its total imports — with the heaviest reliance on U.S. imports concentrated in certain agricultural products, aircrafts and parts, and select metal inputs for manufacturing.

Supply Chains in Focus

To narrow the scope of this paper, Business Roundtable commissioned an in-depth analysis of critical sectors of the U.S. economy to better understand the risks and opportunities posed by China's integration in related supply chains. **The process had three steps:**

— **Identify critical supply chains.** The analysis reviewed over 1,000 supply chains across over 30 industries to identify those most critical to U.S. national and economic security.

— **Review existing policies and corresponding risk mitigation.** Some critical supply chains are already subject to existing or recently enacted policies to mitigate risk and build resiliency. These supply chains, as well as those covered through prior Business Roundtable projects, were removed.[6]

— **Index and prioritize based on materiality and vulnerability.** The remaining supply chains were then evaluated for materiality (i.e., share of imports, economic importance) and associated vulnerability (i.e., import concentration from individual countries, underlying difficulty to diversify) using holistic qualitative and quantitative criteria.

Based on the results, this paper focuses on five specific supply chains with strategic significance when considering China's positioning in the global marketplace:

— **Critical Minerals and Materials**

— **Synthetic Active Pharmaceutical Ingredients (APIs)**

— **Agrochemicals (e.g., crop protection)**

— **Printed Circuit Boards (PCBs) and Printed Circuit Board Assembly (PCBA)**

— **Foundational Semiconductors**

These supply chains heavily impact key industries: healthcare, information and communications technology, aerospace and defense, agriculture, automobiles and electric vehicles, manufacturing and machinery, and energy. These supply chains also produce critical intermediate goods, thus having impacts not always apparent in direct trade flow data. Building resiliency in these supply chains would not only safeguard U.S. long-term economic and national security interests but could also provide a framework to de-risk other supply chains and U.S. global trade more broadly.

Opportunities for Global Cooperation

International trade and investment play a critical role in the U.S. economy. The United States is the second-largest trading country and is the largest source and recipient of foreign direct investment.[7] International trade and investment support American innovation, jobs and families while creating higher standards of living around the world. Despite the United States having Free Trade Agreements (FTAs) with 20 countries, only one-third of U.S. imports are sourced from these trading partners. As of 2022, China accounted for approximately 17% of total U.S. imports and approximately 25% of U.S. imports from non-FTA countries. Additionally, the United States has not added a new FTA partner or negotiated an entirely new trade deal since 2012. As a result, China's trade agreements today reach out to about $14.4 trillion in global gross domestic product (GDP), compared to $9.6 trillion for the United States.[8]

Globally, China accounts for a significant proportion of production at numerous essential stages of the five supply chains in focus *(see Figure 1)*.

Figure 1: China global production share for key supply chains (2021)

Note: For foundational chips, the statistics are for pure-play foundries that fabricate chips and contract manufacturers (~85% of future capacity growth in foundational chips is expected to come from pure-play foundries) | For Synthetic APIs and Agrochemicals, the import share represents raw materials / key starting materials and not APIs/Agrochemicals themselves.

~55%

PCB/PCBA

PCB Manufacturing

~75%

Foundational Chips

Foundational Chips Manufacturing

Taiwan (~49%); China (~26%)

Note: *Going forward, China is adding more incremental capacity (~50% share of global growth) than Taiwan.*

~45%

Pharma-Synthetic APIs

Synthetic API Raw Materials

~40%

Agrochemicals

Agrochemical Raw Materials

~75%

Critical Minerals

Average across Lithium, Cobalt, Nickel, Rare Earth Elements, Graphite and Gallium

Source: *Analyst reports; Gartner; Trademap; Euromonitor; Lit. search*

Identifying potential trading partners that can provide alternative sources for critical inputs and an enabling business environment for establishing new manufacturing and processing facilities at cost-effective rates will be key to diversifying supply chains. Furthermore, because of the persistently tight U.S. labor market, among other considerations, U.S. capacity to onshore significant portions of these supply chains is limited.

Many companies have already begun to diversify supply chains, but it is often a long and resource-intensive process. This section presents broad recommendations for policymakers to promote global cooperation and help the private sector build resilience.

Recommendations

Deepen economic partnerships and economic integration agreements with countries exposed to lower geopolitical risk to fill gaps in critical domestic supply chains and minimize the risk of adverse trade actions that would increase costs for U.S. consumers. **The United States could deploy several strategies to reduce tariff and non-tariff barriers to trade with key partners through new or updated comprehensive FTAs:**

- **Identify opportunities to expand and update existing FTAs to lower tariffs** on critical supply chain inputs and intermediate products, increase regulatory coherence, promote more efficient customs administration procedures, increase mutual recognition of labor and environment standards, and support supply chain integration initiatives for manufacturing value chains with the goal of creating a better enabling environment for manufacturing and sourcing in those countries.
- **Establish strategic supply chain funds at U.S. development agencies** to facilitate financial support for new project development to expand raw material and intermediate manufacturing capacity in partner countries.
- **Embrace strong digital trade rules** to ensure the free flow of data critical to advanced manufacturing, prevent onerous data localization policies that do not serve legitimate regulatory purposes, and safeguard against laws and regulations that condition market access on technology transfers.
- **Encourage adherence to international standards and openness in national standards-setting processes** to promote interoperability of products in U.S. supply chains.
- **Strengthen mutual recognition agreements** and upgrade good regulatory practice chapters in existing FTAs.
- **Work with allies and partners to prevent ocean carrier alliances from engaging in anticompetitive practices** during periods of intense supply chain disruption.
- **Urge Congress to amend trade preference, procurement and trade promotion authority statutes** to better integrate U.S. and key trading partner supply chains. For example, Congress could amend the Trade Agreements Act of 1979 (TAA) to expand the list of countries whose products are eligible for U.S. government procurement to include all trading partners that have provided preferential market access and liberalization

commitments to the United States. Congress also should renew our key trade preference programs — the Generalized System of Preferences, the African Growth and Opportunity Act, and the Caribbean Basin Initiative — to ensure greater access to critical inputs on a duty-free basis. Finally, Congress should pass new trade promotion authority legislation with supply chain integration negotiating objectives. This legislation should require that new trade negotiations facilitate private sector supply chain resilience initiatives with enforceable market access commitments, including reduced tariff bindings, clear rules of origin, protections for intellectual property and investment, obligations to promote the cross-border services trade, and digital trade rules that promote the free flow of data and minimize localization barriers, while at the same time raising labor and environment standards in trading partner territories.

In the interim, while pursuing new and/or updating existing FTAs, policymakers should examine whether additional bilateral or plurilateral agreements that provide clear, cross-sector benefits and are WTO-compliant could be negotiated to facilitate the integration of specific supply chains. Those agreements should focus on reducing market access barriers, promoting policy predictability, harmonizing regulatory standards, increasing intellectual property rights protection, and raising environmental and labor standards to facilitate supply chain resilience.

Identify prospective partners with demonstrated potential for growth in targeted supply chains with whom the United States should seek additional market access and liberalization commitments *(see Figure 2)*:

Figure 2: Potential Alternate Trading Partners for PCBs, Foundational Chips and Agrochemicals

Example countires with low labor costs, existing infrastructures and low geopolitical risks that present diverse supply chain opportunities for the U.S.

	Malaysia	Vietnam	Thailand	Indonesia	India	Mexico	Brazil
PCB / PCBA	✓	✓	✓			✓	
Foundational Chips	✓	✓				✓	
Agrochemicals	✓		✓	✓	✓		✓

— **Southeast Asia** has several countries with growth potential in critical supply chains, though proximity to and influence from China remain factors for consideration. **For example:**

- **Malaysia and Vietnam** are seeing an increase in semiconductor assembly, testing and packaging as industry diversifies from Taiwan and China.
- **Thailand** is emerging as a favorable market for PCBs with suppliers of both PCBs and key PCB material (e.g., copper clad laminate) increasing their presence in the country.
- **Indonesia** is increasing its agrochemical production as exports of crop protectors in 2022 rose 30% and organic chemical exports to the United States rose 55% [9, 10]

— **India** is challenging China across many sectors with competing labor costs and broadly scaled manufacturing with dedicated government support. For example, India manufactures approximately 25% of global generic drugs and has over 60 Food and Drug Administration (FDA)-approved API sites capable of producing 30 or more APIs each. After China, India is a top supplier of chemical starting materials. It also has a strong export-oriented agrochemicals (crop protection) sector growing at 12% to 14% annually. Additionally, it is emerging as an electronics manufacturing hub, as leading firms shift production to India, which can be seen in Foxconn's recent India investment to make mobile phones.

— **Mexico** is party to a robust FTA with the United States, the United States-Mexico-Canada Agreement (USMCA), in addition to its ideal proximity to the U.S. market. At least three significant PCB manufacturers are headquartered in Mexico.

— **Brazil** is an alternative source of agrochemicals and synthetic APIs in addition to having significant reserves of certain critical minerals.

Regarding APIs, the United States should work closely with existing trading partners to enable supply chain expansion. To expand access to APIs for patented medicines, U.S. trade strategy should include a focus on updating existing agreements with Australia, the European Union, Japan, Singapore, South Korea and the United Kingdom. To expand access to synthetic APIs for use in generic drugs, where low-cost margins are crucial, U.S. trade strategy should include the exploration of new arrangements with countries that have less geopolitical risk and high potential for increased capacity, including Brazil and India. These new arrangements should address customs procedures, intellectual property protections, increasing protectionism based on national standards treatment and other market access barriers. Similar concerns would need to be addressed with Mexico in updating the USMCA.

When it comes to critical minerals and materials, existing trading relationships and access to natural resources and minerals processing are key factors for consideration. *See Figure 3* for a list of some prospective partners in the critical minerals supply chain.

Figure 3: List of prospective partners in the critical minerals supply chain

These countries present an opportunity for U.S. minerals interests given existing relations, high concentrations of the world's mining production and reserves of key minerals, potential to improve environmental and labor conditions, and the ability to combat growing influence from foreign competitors:

	Indonesia		South Africa	Brazil		Philippines	European Union	
Most Prominent Mineral(s)	**Nickel**	**Copper**	**Platinum Group Metals**	**Graphite**	**REEs**	**Nickel**	**Chromium**	**Cobalt**
Concentration of world production and reserve	~50% mine production ~40% processing	~4% mine production ~3% global reserves	~75% platinum mining ~90% processing	~23% global reserves	~17% global reserves	~10% mining production	~5% mining production	~15% processing
U.S. Import Reliance	>50%	41%	>50%	100%	>95%	>50%	~75%	~75%
Other Considerations	Growing Chinese investment in Indonesian nickel mining and processing over the last decade.	Significant processing capacity expected to come online in 2023.				Ongoing USTDA critical minerals project with Eramen Mineral to support mineral processing standards in Philippines.	Processing is a critical step in the supply chain and is led by China for most mineral commodities (e.g., ~70% of cobalt processing).	

Note: *Platinum Group Metals are iridium, osmium, palladium, platinum, rhodium and ruthenium*
Source: *U.S. Geological Survey, International Renewable Energy Agency, Bank of America Global Research, U.S. Trade and Development Agency, International Energy Agency*

Cross-Cutting U.S. Domestic Policy Recommendations

Underpinning supply chain resiliency in the focus supply chains — and for the U.S. economy broadly — are key policies to enable strong economic growth. Fragility or gaps in these areas create operational and strategic risk, and addressing the challenges in each is critical to building overall supply chain resilience. Factors that underpin the ability to develop strong supply chains domestically include:

- **A competitive tax system;**
- **A skilled workforce; and**
- **Streamlined regulatory processes.**

Competitive Tax System

A competitive tax code ensures that businesses continue to prioritize the United States as a primary location for investment, production and job creation. Business investments generate new local tax revenues and help provide for the future prosperity of American families. As other countries prioritize economic growth, the United States needs to keep pace with its global competitors. Doing so will require maintaining a competitive tax environment.

The corporate tax rate, the income base against which it is applied and the way in which the United States taxes income earned in foreign markets all affect the incentive to invest and create jobs in the United States. A more attractive U.S. tax environment gives both U.S.- and foreign-headquartered companies an incentive to invest more capital — equipment, technology and other facilities — in the United States. Economists agree that increased investment increases productivity and, in turn, increases wages for workers. Reforms in the 2017 Tax Cuts and Jobs Act (TCJA) resulted in historic wage and job growth and investment in the United States. Prior to the 2017 reforms, the U.S. corporate tax rate was the highest among industrialized countries. The new combined federal and state corporate rate of 25.8% puts the United States in the middle of Organisation of Economic Co-operation and Development (OECD) countries — higher than 23 of our 37 OECD competitors, including Belgium, Spain and the United Kingdom.

The federal government can stimulate private sector investments in research and development (R&D) through targeted tax provisions that allow companies to claim credits on research expenditures. These incentives are intended to spur entrepreneurial activity

and generate spillover effects that boost overall economic growth. For nearly 70 years, the U.S. tax code has allowed businesses to fully deduct their R&D expenses in the year in which the spending occurred. However, since 2022, businesses now must amortize these expenses over a period of five years, making R&D more costly to conduct in the United States. As a result of this change, the United States is now one of two developed countries requiring the amortization of R&D expenses. Meanwhile, China currently provides a super deduction for R&D expenses up to an extra 100% of eligible R&D expenses in addition to actual R&D expenses.[11] At a time of increasingly fierce global competition for research dollars, current uncompetitive tax policies make it harder for the private sector to invest in R&D in the United States, which also hurts the ability to invest in critical supply chains.

Recommendations

Ensure the United States maintains a competitive tax code that allows businesses to continue prioritizing the United States as a primary location for investment and job creation, **including in key portions of critical supply chains:**

- **Maintain a competitive 21% corporate tax rate** to make the United States more attractive for manufacturing and production activities that underpin critical supply chains.
- **Maintain and strengthen an approach to the taxation of international earnings** that incentivizes owning intellectual property in the United States and keeps the system of minimum taxes on foreign income competitive.
- **Restore the full expensing for research R&D investments and bonus depreciation provisions** to incentivize companies to expand research and domestic manufacturing capabilities.
- **Support state and local tax incentives, as well as Regional Technology and Innovation Hub (Tech Hubs) designations through the U.S. Economic Development Administration,** to encourage states and localities to grow the U.S. technology ecosystem.

Workforce

Workers and businesses today are navigating a rapidly changing economy. Technology and innovation are constantly creating demand for new skills. The United States needs a workforce that is ready today and can acclimate to future changes. The foundation of an "ever-ready" workforce is a commitment to fostering continuous learning, adaptability and new ways to meet the ever-evolving realities of the economy and work.

Examples From Focus Supply Chains:

- The manufacturing sector expects 2.1 million unfilled jobs by 2030.
- The pharmaceutical industry mirrors these issues with a 3.4 million worker deficit projected by 2025, fueled by 80% of pharmaceutical companies reporting a skills mismatch.
- Roughly 67,000 semiconductor manufacturing and design jobs risk going unfilled by 2030 *(see Figure 4)*.

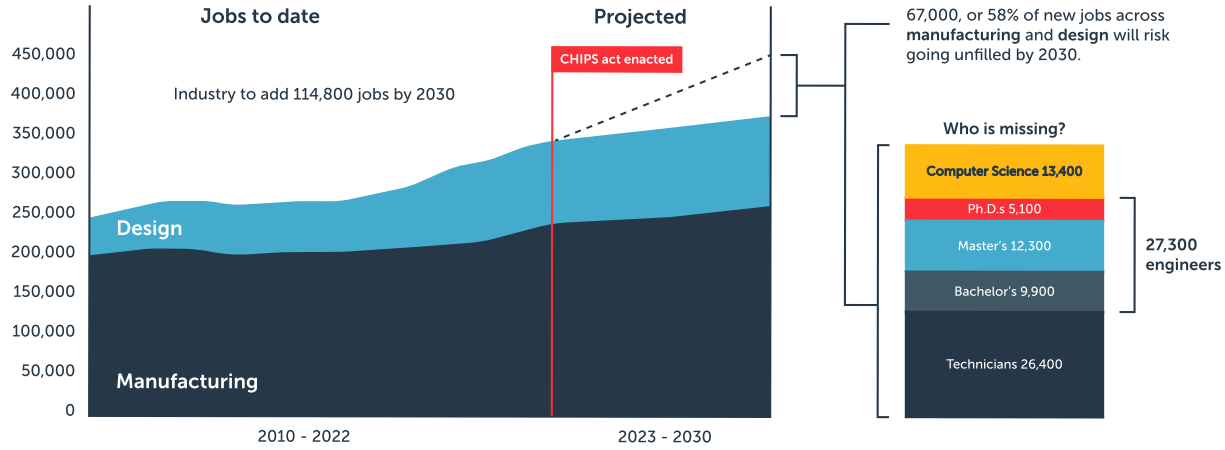
China and India have steadily outpaced the United States in adding science and engineering (S&E) degree-holders, with China more than tripling its graduates since 2003 while the number of U.S. graduates with S&E degrees has remained stagnant. Moreover, U.S. industry faces both a workforce shortage and a skills mismatch.

Opening pathways for employment and advancement is more important than ever, with a historically tight labor market, a shrinking working-age population and historically low workforce participation. A lack of accountability in workforce development is also contributing to subpar outcomes and a disconnect between training programs and employers' needs. This deficiency intensifies the skills gap, posing increased challenges for employers who are looking for candidates with the requisite skills for sought-after positions.

To meet the growing demand and, in some cases, shortage of workers in key supply chains, the United States must expand the workforce across all sectors to include those with and without college degrees. These roles include research engineers, advanced manufacturing technicians and others across the spectrum.

Reforms to the public workforce development system will complement the significant efforts many companies are taking to build a world-class modern workforce. Sound public policy that accounts for business and industry needs is key to ensuring a skilled and productive U.S. workforce.

Figure 4: **Projected workforce shortage in the semiconductor industry**



Source: *Semiconductor Industry Association*

Recommendations

Modernize the public workforce development system to build an ever-ready workforce that leads to expanded opportunity for workers and strengthens U.S. competitiveness. Broadly, **Congress and the Administration should:**

— **Improve the Workforce Innovation and Opportunity Act** to direct resources to training programs that focus on in-demand careers, including those requiring STEM-related skills.

- Ensure funding targets upskilling and reskilling workers through individual training accounts, on-the-job-learning and other industry-led training.
- Promote employer-driven programs that equip workers with the skill sets to fill jobs in critical sectors.

— **Expand Pell Grant eligibility** for students pursuing high-quality, short-term education and training programs.

— **Incentivize community colleges and other high-quality providers,** such as career and technical education centers, to work with local businesses to develop skills-based training programs, including a range of work-based learning models.

— **Modernize the U.S. Department of Labor's Registered Apprenticeship system** to be more flexible, better aligned with career pathways across industry sectors, and recognize employers' increased focus on skills, not just degrees, in hiring and career advancement.

— **Expand tax incentives** that promote investments in upskilling and reskilling and lead to increased mobility for workers.

— **Reform the employment-based immigration system** to attract and retain foreign talent.

- Retain foreign-born graduates of U.S. colleges and universities, especially those with advanced STEM degrees, by preserving programs that allow them to work after graduating, like Optional Practical Training, and exempt individuals with advanced U.S. STEM degrees from the employment-based green card limit. Currently, most master's and Ph.D. candidates in the United States are foreign citizens. Yet ~80% of master's graduates and 25% of foreign Ph.D. STEM graduates from U.S. institutions leave the United States following graduation, either voluntarily or due to U.S. immigration policies.
- Adopt changes to the H-1B program that minimize employment disruptions, provide flexible pathways to the United States and support skills-based employment practices. The current numerical limits (85,000) and restrictions on the H-1B program make it difficult for employers to hire and retain talent in the U.S. and lead multinational companies to move work to other countries, including China, India and Canada.
- Expand the H2-A program and allow visa holders to work in year-round positions.

Streamlined Regulatory Processes

Domestic manufacturing is challenged by inefficient permitting processes and other burdensome regulatory requirements.[12] The United States has well-established high environment, health and safety (EHS) standards, which Business Roundtable generally supports. However, policy should be tailored to balance regulatory needs with global competitiveness to build a more resilient and efficient manufacturing ecosystem. For example, recent legislation amending the National Environmental Policy Act (NEPA) will improve permitting processes while maintaining high environmental standards if fully implemented.[13] However, further improvements are needed.[14]

To enhance domestic capabilities for the critical supply chains in scope, the United States can and should streamline permitting, reduce regulatory complexities and expedite approvals, without risking safety or environmental standards.

Recommendations

Streamline the regulatory framework and permitting processes for critical supply chains to expedite market entry, foster innovation and promote resiliency.

- **Require agencies** to abide by sound science and efficient, data-driven risk assessment, including strengthening stakeholder engagement. Regulatory agencies should abide by international standards and practices to ensure U.S. domestic manufacturing remains competitive.
- **Shorten decision timelines by utilizing updated technology and best practices.** For projects that require environmental review, require agencies to issue final decisions within 90 days of completing an environmental impact statement and provide preliminary feedback on application completion and accuracy within 14 days of submission.
- **Digitize operations** by supporting implementation of a centralized digital system for agencies to streamline processes, including application submissions, necessary document uploads, feedback for revisions and status updates.
- **Differentiate and prioritize projects** by revising project permitting requirements in areas with ongoing operations and community engagement.

Policy Recommendations to Strengthen Targeted Supply Chains

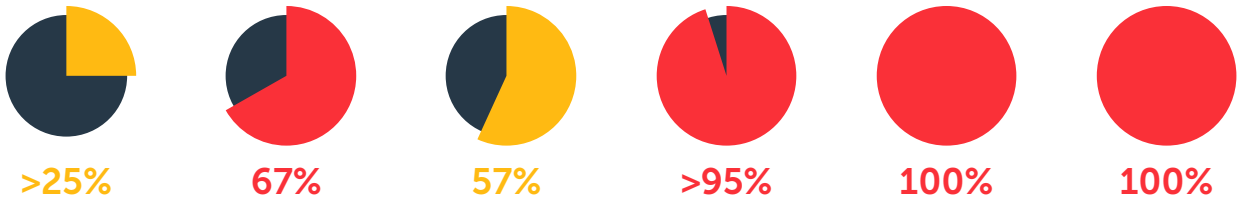
Recommendations for U.S. policies targeted to each specific supply chain

Critical Minerals and Materials

The United States is highly dependent on imports for critical minerals and materials due to limited available supply and headwinds in scaling domestic mining, processing and recycling capabilities *(see Figure 5)*. U.S. mining and processing capabilities for several minerals have atrophied over recent decades in the face of unfavorable market conditions and insufficient policy support. Metals mining in the United States decreased by around 25% between 1990 and 2018, leaving significant untapped potential in domestic resources of minerals such as lithium, copper and rare earth elements.

While there is near-term domestic opportunity for the United States to build its processing capacity, China currently holds a substantial share of processing for many critical minerals that are key to several industries such as technology, energy and healthcare.[15] For example, China holds 98% of the processing share for gallium, a key input to the semiconductor industry.[16]

Figure 5: **U.S. reliance on imports for key critical minerals, select uses, top supplier (2023)**



>25%	67%	57%	>95%	100%	100%
Lithium (Li)	**Cobalt (Co)**	**Nickel (Ni)**	**Rare Eath Elements**	**Natural Graphite (C)**	**Gallium (Ga)**
Rechargable batteries Ceramics & glass Lubricating greases	Electric Vehicles Gas turbine engines Automobile airbags Chemical catalysts	Stainless steel Jet turbines Battery storage Solar PV	Mobile/TV displays LEDs Automobile magnets Wind turbines	Lithium-ion batteries Brake linings Nuclear reactors Electric motor brushes	Semiconductors Power amplifiers LEDs Solar cells
Top Supplier: Argentina	**Top Supplier:** Norway	**Top Supplier:** Canada	**Top Supplier:** China	**Top Supplier:** China	**Top Supplier:** China

Note: *Top supplier over 2019-2022* ***Source:*** *U.S. Department of Energy. U.S, Geological Survey*

While the United States imports most of its gallium as processed wafers from South Korea, Japan and Germany, all of these countries import raw and processed gallium from China, which recently placed export controls on the mineral. In 2022, China was the leading import source for 17 of the more than 50 mineral commodities for which the United States is more than 50% reliant on imports.[17]

The United States has begun implementing policies to incentivize processing for a select set of minerals and materials deemed important for national and economic security based on the U.S. Geological Survey (USGS) list of 50 critical minerals most recently updated in 2022 and the Department of Energy's (DOE) list of critical materials. This includes the recent enactment of a 30% investment credit to qualifying projects, including re-equipping, expanding or establishing facilities for processing and refining or recycling critical minerals and materials as defined by USGS and DOE.

While ongoing efforts have helped smooth regulatory hurdles and reduce production costs for some minerals, USGS' and DOE's existing criteria for designating minerals and materials as "critical" can fail to capture anticipated demand and omit materials that are pivotal for the energy transition (e.g., copper).

Circular supply chains present a significant opportunity to develop more secure and reliable access to critical minerals and materials that may be in global short supply or for which the United States may be heavily reliant on geopolitically unstable sources. A wide range of products commonly used in consumer and commercial applications contain rich stocks of critical minerals and materials that can be reclaimed, processed and reinserted into supply chains. Key challenges to realizing broader circularity today are a lack of cost competitiveness between linear and circular supply chain models and the absence of efficient mechanisms for the cross-border movement of used and end-of-life products and materials recovered from them. In many cases, these challenges are exacerbated by regulatory and trade barriers that, while intended to protect against harms caused by unregulated trade in potentially hazardous materials, do not provide avenues for responsible trade that benefits both the environment and resiliency of materials supply.

Recommendations

— **Adjust the standards** used by USGS and DOE to determine mineral and material criticality and ensure both lists accurately reflect the near-term risk of anticipated supply deficits, with ample opportunity for input from stakeholders.

- **Make official and consider expanding the draft list of critical materials** to enable access to advanced energy project tax credits (26 U.S.C. § 48C) and DOE grant and loan programs.
- **Reform the permitting process for domestic mining and processing** to make available more resources in a safe, expeditious and predictable way.
- **Leverage ongoing work and models** in international forums and bilateral and regional dialogues to build and expand pilot trusted trader programs for resource recovery trade.
- **Support research** to enhance recoveries of strategic minerals and develop artificial substitutes that lessen dependence on foreign-sourced critical minerals.

Synthetic Active Pharmaceutical Ingredients

In 2022, the United States imported approximately $170 billion worth of pharmaceutical medicines, with China accounting for only 7% of these imports and a large portion coming from countries such as Ireland, Germany, India and Italy.[19] However, the significance of China's role becomes more apparent when considering that China supplies a substantial amount of the raw materials needed for final formulations and intermediates, such as for synthetic APIs, which produce a medicine's intended outcomes. This illustrates the greater upstream dependency in the generic market, which is more reliant on synthetic APIs as opposed to biologics.

China's advantage is a result of many factors. EHS regulations in the United States, EU and other developed economies and regulatory barriers have made manufacturing of key components and starting materials in critical sectors increasingly cost prohibitive. For example, chemicals manufacturing (most importantly bulk chemicals) generates key starting materials for numerous major supply chains, including pharmaceuticals. The share of Chinese materials in some common and essential medicines such as amoxicillin (antibiotic) and some over-the-counter vitamins can be as high as 90%, and less than 5% of global large-scale API manufacturing sites remain in the United States today.[20, 21]

Complex regulatory processes also impact the API supply chain. The standard review of new drug applications, including the approval of the synthetic API supplier, is a process that takes a minimum of 12-15 months, excluding clinical trial years. Despite the FDA's streamlining certain processes, receiving approval for a new supplier of an essential generic medicine API

still requires around four months. The lengthy process, which can be further delayed, can add cost and make it more difficult for manufacturers to change or add suppliers.

Recommendations

- **Expand Mutual Recognition Agreements (MRAs) with allies and partners** to drive ease of approvals and expedite global change rates for pharmaceutical APIs and promote expansion of the Australia-Canada-Singapore-Switzerland-United Kingdom Consortium (ACCESS) of drug regulators to countries that meet high regulatory standards. Japan and South Korea are two countries where MRAs would be helpful in streamlining the approval process in a manner that encourages greater supply chain integration with suppliers capable of meeting high standards. Consider accelerated approvals for manufacturers when high standards have been met, move to e-labeling to facilitate speed and efficiency of label revisions and increase staff in countries of strategic importance, including India.

- **Promote the use of advanced manufacturing and process intensification techniques.** For example, continuous manufacturing provides more control over batch production processes by increasing efficiency, reducing waste and lowering chemical manufacturing costs. At the same time, computational materials engineering tools can expedite the design and deployment of new materials and processes, enhancing chemical manufacturing by optimizing production and cutting time-to-market.

- **Invest in domestic capabilities for pharmaceutical research support (e.g., early-stage API manufacturing, process engineering)** to allow American companies to better match the cost structure and speed of Chinese competitors that benefit from Chinese government support.

- **Ensure funding (e.g., from Generic Drug User Fee Amendments) is deployed** to provide agencies with the tools and resources needed to implement timely approval, inspection and permitting programs.

- **Further expedite Abbreviated New Drug Application (ANDA) timelines for FDA-approved suppliers and manufacturers of generic essential drugs,** including through pre-approval chemistry, manufacturing, and controls confirmation and commitment. At time of initial or supplemental approval and upon review of the process supply chain, the FDA or the European Medicines Agency should consider granting an expedited

review if the manufacturer has built it to be resilient and commits to it remaining so.

— **Finalize and drive adoption of the Quality Management Maturity (QMM) program** for operational excellence within synthetic API production. Through standardized evaluations, continuous process improvements and risk management, QMM will enable the FDA to achieve more streamlined, efficient and consistent approval processes by providing a clear framework and guidelines for manufacturers.

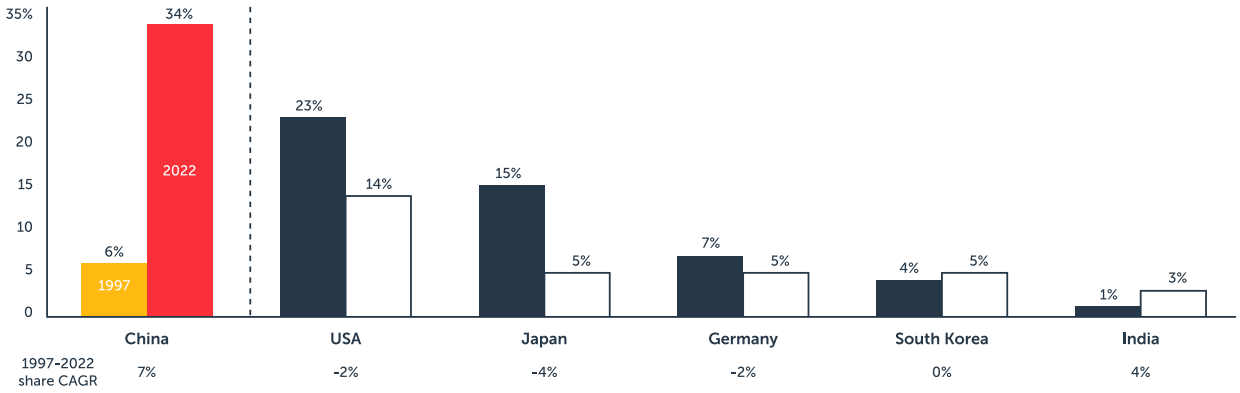
— **Expedite label change approvals and manufacturing process change approvals** requested by manufacturers (e.g., to change registered source materials) to allow greater manufacturer flexibility to adjust suppliers, as needed, to increase reliability and create efficiencies.

Agrochemicals

While growth of the chemical sector in the United States has declined, corresponding Chinese manufacturing has grown, supported by state-led policies and wide use of chemical inputs into its broader manufacturing industry *(see Figure 6)*.

Figure 6: China is leading chemicals manufacturing and taking production share from others

Basic chemical manufacturing global production share in 1997 and 2022 by country

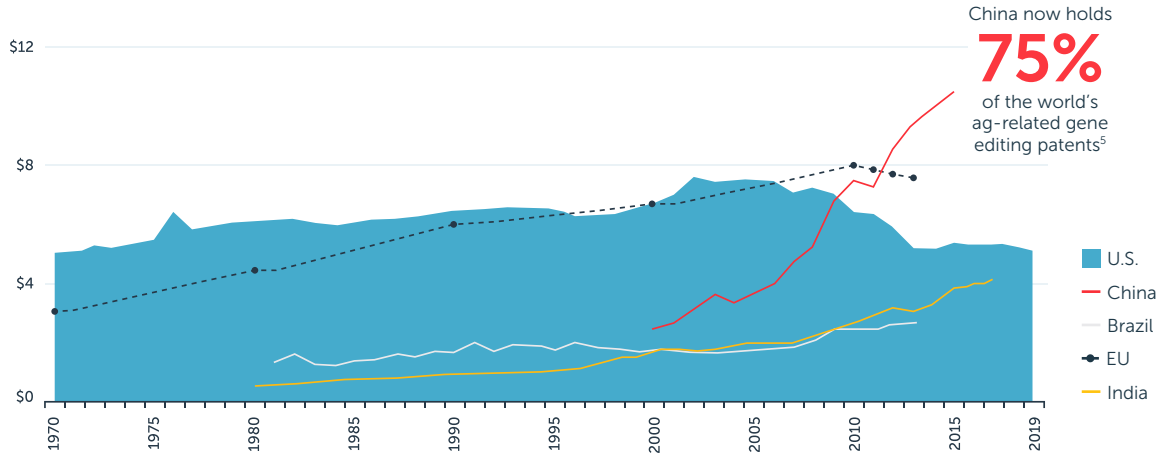


An important element of China's dominance of the agrochemical supply chain is the role played by State-Owned Entities (SOEs), which have broad freedom to operate in the United States. This includes the ability to sell chemical, seed and digital products directly to U.S. farmers, own agricultural land, maintain political influence over and equal access to the U.S. regulatory system, and claim eligibility for local tax breaks. Conversely, U.S. agricultural technology companies seeking to operate in China are severely limited by Chinese national security laws related to agriculture and regulatory favoritism that effectively prevent registration of new pesticides and licensing or selling seeds in China. Reciprocity with Chinese agrochemical SOEs is a critical first step to making U.S. companies competitive suppliers in a secure supply chain.

Dedicated R&D investments for innovative technologies and products within agrochemicals would help the United States lower costs to better compete with other countries while reducing risk and increasing the country's competitive advantage. China is far outpacing United States agriculture research investment. The lack of domestic investment makes U.S. farmers more reliant on foreign investment and technology and poses a threat to their ability to compete on a global stage *(see Figure 7)*. Government action should aim to broaden and diversify supply, including through innovation across a wide spectrum of crop protection products, and promote greater self-sufficiency, productivity and efficiency to maintain a more resilient system.[22]

Figure 7: **Public funding of ag research in the U.S. and other countries**

Investment in public Ag R&D [3,4] (Billions of Dollars)



Source: *USDA, Economic Research Service (2022).*
https://www.ers.usda.gov/data-products/agricultural-and-food-research-and-development-expenditures-in-the-united-states/

The agrochemical industry is among the most regulated in the United States. The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and the Pesticide Registration Improvement Act (PRIA) establish frameworks for bringing new pesticide products to market. The approval process takes on average 11 years from the lab to the farm.[23] This disincentivizes companies from researching and developing innovative agricultural technologies that would diversify crop protection product supply chains in the United States.

Recommendations

- **Invest in domestic capabilities for developing and scaling innovative and emerging technologies** to expand critically needed R&D within both U.S. public institutions and private industry. This would promote capital investments that enable U.S. industry to compete with companies from growing markets, including China and Brazil.
- **Design focused policy interventions targeting manufacturing and processing of key inputs** (e.g., starting chemicals) in critical supply chains with alternate forms of capital expenditure support (e.g., direct subsidies, low-interest loans, co-investment funds, public-private partnerships) — prioritizing products with highest risk of supply disruption.
- **In talks with the Chinese government, prioritize the need for reciprocal treatment for U.S. companies operating in China** to allow American companies to compete on an even playing field with their Chinese counterparts.
- **Streamline the federal registration process for new products and the approval of foreign facilities** by identifying and eliminating redundancies in the interagency review process, aligning high-quality labor, environmental and health standards with allies and partners for pesticide production and distribution, and modernizing technology used in the review process.

Printed Circuit Boards and Printed Circuit Board Assembly

The United States was once the world's leading electronics manufacturer. Over the last few decades, the U.S. PCB industry has experienced significant contraction and financial instability. The U.S. PCB industry, which once had more than 2,000 companies and 30% of the global market, now has fewer than 150 companies and only 4% of global production. The decline of domestic industrial production is the result of both capacity contraction and a loss of manufacturing capability. Approximately $11 billion worth of PCBs were produced

annually in the United States prior to the shift in production to Asia in 2000-2001. In 2000, North America had the largest number of PCB facilities globally, with approximately 780. By March 2020, that number had fallen to an estimated 230, while the number of facilities in China increased to 1,480 over that time.

Asia now produces more than 90% of all PCBs, with China accounting for more than 55% of global production. The rise in production is driven by lower costs in labor and raw materials, as well as government subsidies for the construction and equipment of PCB manufacturing plants. Around 65% of the copper clad laminate required for PCBs is produced in China, and about 60% of PCB active components are produced in Taiwan. PCB and PCBA is a low-margin business with an average operating margin of 7% to 13%.[24] This makes the economic viability of production outside of China even more difficult.

The U.S. Department of Homeland Security and the U.S. Department of Commerce highlighted the increased concentration of PCB production and assembly in China in their review of supply chains for critical sectors and subsectors of the U.S. information and communications technology industrial base. The report highlighted aspects of the domestic PCB supply chain that make scaling difficult, including the age and inefficiency of existing U.S. plants and heavy reliance on defense contracts given U.S. PCB manufacturing firms' inability to compete on price.

Recommendations

- **Ensure PCBA is included in PCB targeted incentives.** Currently, tax credits available to PCB manufacturers do not apply to PCBA. Expanding the qualifications to PCBA will help prevent PCBs made in the United States from being sent overseas for assembly.
- **Fully leverage the $500 million provided to the U.S. Department of State under the CHIPS and Science Act** to include PCBs and PCBA in allied countries with low trade barriers, such as Mexico.

Foundational Semiconductors

The U.S. share of global semiconductor production has fallen precipitously over the past few decades. U.S. companies account for 48% of the world's chip sales, but U.S.-located fabs only account for 12% of the world's semiconductor manufacturing, down from 40% in 1990. The cost of manufacturing semiconductors in the United States is 30-45%

higher than in the rest of the world. Foundational semiconductors, which are used in the automotive, defense and aerospace industries, are a critical part of U.S. economic and national security. According to a survey from the U.S. Department of Commerce released in 2022, during the COVID-19 supply shortage, firms faced the most acute shortages not in cutting-edge chips but in foundational chips.[25]

China is particularly focused on investment in foundational node capacity, providing the Chinese semiconductor industry with an estimated $150 billion in government subsidies over the past decade. According to the Bureau of Industry and Security in its 2023 assessment of the capabilities of the microelectronics industrial base, this investment is likely to drive prices below market pricing for foundational semiconductors and disadvantage U.S. and other foreign competitors. China also has an advantage in raw materials, processing about 70-75% of silicon required for wafers. Semiconductor assembly, testing and packaging is also concentrated in China and Taiwan, driven by low margins and high costs.

The United States has recognized this vulnerability across semiconductor manufacturing broadly, and Congress recently passed the CHIPS and Science Act, which invested $52 billion into creating incentives for domestic semiconductor design, manufacturing and research. Of that funding, $2 billion was dedicated to foundational chips.

Recommendations

- **Through implementation of the CHIPS and Science Act** engage with industry to identify areas of highest need in the innovation ecosystem for foundational chips, increase U.S. competitiveness in the full semiconductor supply chain, and periodically assess the efficacy of these initiatives in expanding the U.S. semiconductor industry and innovation pipeline for foundational chips relative to comparable foreign government industrial policies.
- **Consider a long-term strategy that supports manufacturing** of critical technologies, including foundational chips that have lower margin profiles.

Conclusion

Resilient supply chains are vital for U.S. businesses due to their ability to withstand and swiftly recover from disruptions. In an increasingly interconnected global economy, disruptions can arise from various sources, including natural disasters, geopolitical tensions, pandemics and economic crises. Maintaining resilient supply chains enables businesses to mitigate the impact of such disruptions, ensuring continuity in operations and minimizing financial losses. Moreover, resilient supply chains offer businesses a competitive edge by enhancing their agility and responsiveness to changing market conditions, customer demands and regulatory requirements.

Corporate leaders are acting on this urgency, but a more sophisticated and sustained policy response is needed both broadly and in targeted supply chains. Single country dependency remains a recurring risk factor in deeper parts of the value chain, where cost structure and scale create significant barriers for the United States and other countries to make immediate and meaningful progress.

The U.S. government must enlist key trading partners and allies and expand strategic relationships to foster a collective effort towards global supply chain resilience. Smart domestic policy is also crucial for the growth of and access to alternate supply sources, both domestically and through strategic partners. A holistic government effort would include a robust trade agenda, a competitive tax system, investments in skilled labor and streamlined regulations.

While the U.S. government has taken steps to build resilient supply chains, the actions outlined in this report are urgently needed to bolster the United States' long term economic strength.

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