

The Future of U.S. Supply Chains: National Security and the Pandemic

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The COVID-19 pandemic has been the most significant economic disruption to the international economy since the Great Depression. The IMF estimates that the global economy contracted by 3.5 percent last year, while the WTO has projected a 5.3 percent decline in global trade.¹ The economic impact on the United States has been significant as well. Early in the pandemic the United States experienced shortages of critical medical supplies and products, while the need to social distance has continued to place restrictions on the overall economy. For 2020, the pandemic saw GDP decline by 2.3 percent, while exports fell by 12.9 percent and imports by 6.4 percent. All of this has resulted an increased focus on supply chains and their vulnerabilities.

While COVID-19 has raised concern about disruptions to U.S. supply chains, the pandemic is not the only disruption that supply chains have faced in recent years. Over the last decade, natural disasters such as the 2011 earthquake and tsunami in Japan and political shifts such as the United Kingdom's decision to leave the European Union, have disrupted supply chains. As the McKinsey Global Institute notes, these disruptions to supply chains are becoming increasingly frequent. Disruptions of more than 2 months now occur, on average, once every 4.9 years.²

What makes this disruption different is that it is occurring at a time of increasing geopolitical tensions and growing concern over U.S. supply chains' dependence on China. Since 2018, the United States and China have been engaged in a trade war, while the Trump administration began raising concerns about the security of U.S. supply chains in China prior to the pandemic.³ Once the pandemic began, it simply became an additional avenue for the Trump administration to pursue its goal of moving U.S. supply chains outside of China. With the election of Joe Biden as president there had been hope that the United States might pursue different policies, but the Biden administration also placed an emphasis on securing supply chains in light of the pandemic and bipartisan concern over China's role in U.S. supply chains.

To explore these issues, this chapter first examines the Trump administration's approach to China and supply chains. It then considers how supply chains have performed during the pandemic and how the Biden administration and Congress have approached the issue. Lastly, it considers what challenges the administration will face in adjusting supply chains and what options it might have.

The Trump Administration's Trade War with China and Critical Supply Chains

While U.S. policy began to focus more on the rise of China under the administration of Barack Obama, it took a significant turn under Trump, which he foreshadowed during the 2016 campaign, when he singled out China as an unfair trade partner. In a speech on the economy and trade, then-candidate Trump criticized the decision to allow China into the WTO and suggested that he would use Section 301 of the Trade Act of 1974 and other tools to take on China.⁴

Policy began to shift on multiple levels once Trump entered office. What eventually grew into a full-scale trade war began with a decision to accept U.S. International Trade Commission recommendations for tariffs on solar panels and washing machines in October

2017. In early 2018, the Trump administration announced the conclusion of a Section 232 national security investigation that would result in tariffs on imports of steel and aluminum from China and other countries.⁵

The most significant action, however, was the Section 301 investigation of China's practices on technology and intellectual property. The report focused on China's use of subsidies to support industries, forced technology transfers for foreign firms, and restrictive licensing regulations. It concluded that Chinese theft of U.S. intellectual property costs U.S. firms between \$225 and \$600 billion annually. The report also served as the basis for the escalation in tariffs on imports from China that underpinned the trade war.

In parallel to these actions on trade the administration was also reassessing the foreign policy relationship with China. The 2018 National Security Strategy acknowledged the return of great power competition to international relations with China as a main competitor for the United States, while a 2020 inter-agency report on the "United States Strategic Approach to the People's Republic of China" concluded that engagement with China had failed as a policy.

In addition to the tariffs from the Section 301 investigation on China, which the administration hoped would force companies to reconsider production in China, the administration took specific steps to deal with supply chains related to technology and rare earth minerals. It sought to remove China's access to critical U.S. components and placed more than 300 Chinese firms on the Entity List, the most noted of which was Huawei.⁶ At the same time, it sought to discourage countries from deploying 5G equipment from China and worked to convince countries and companies to sign up for a common set of standards under its Clean Network initiative.⁷ Trump also signed Executive Order (EO) 13873 to increase restrictions on the export of U.S. technology.

On rare earth metals, which are critical to defense technology and modern electronics, Trump signed EO 13817 to reduce the U.S. vulnerability to disruptions in the supply of rare earth minerals. The EO sought to develop a list of critical minerals and a plan to support the supply chain for them. The administration released its critical minerals strategy in 2019 and awarded a series of relatively small grants to support mining operations for the defense industry.⁸ It also developed Joint Action Plans on Critical Minerals with Australia and Canada to spur industry cooperation on identifying new sources of rare earth minerals.⁹

Once the pandemic began, the administration utilized it to bolster its argument to return supply chains to the United States. At a Ford plant in Michigan, Trump said "The global pandemic has proven once and for all that to be a strong nation, America must be a manufacturing nation."¹⁰

Peter Navarro called for the return of medical and pharmaceutical production from China and U.S. allies back to the United States saying that "By onshoring more of our pharmaceutical supply chain it will not only be more resilient. It will offer important opportunities to reduce drug prices through the rapid adoption of cutting-edge advanced manufacturing processes."¹¹ Secretary of Commerce Wilbur Ross suggested that the pandemic would "help accelerate the return of jobs to North America,"¹² and USTR Robert Lighthizer argued that the pandemic was accelerating the end of offshoring.¹³

Supply Chain Performance during the Pandemic

The modern supply chain was made possible by the invention of the intermodal cargo container in the 1950s. Over the decades, further innovations in tracking, monitoring, and shipping supplies allowed firms to move towards “just-in-time” production that reduced the need to maintain large levels of inventory, and shrink costs. Those supply chains also began to expand across the globe, creating more points for the types of disruption that have occurred from COVID-19. Despite shortage of products and general perceptions, however, supply chains have on the whole performed relatively well. Initially, supply chain disruptions hit domestic production in China in January 2020. Automakers began to idle plants, and companies such as Apple, that are dependent upon assembly in China, began to examine how to adjust their supply chains. The disruptions, however, were somewhat minimized initially by the traditional closure of factories for the Lunar New Year.¹⁴ Supply chain disruptions did not begin to impact firms outside of China until early February when Hyundai Motors decided to idle all seven of its plants in South Korea due to a shortage of parts.¹⁵ Despite concerns that the pandemic would have a significant impact on supply chains from disruptions to international trade and industrial production, after an initial steep decline both returned to pre-pandemic levels by the end of the year.¹⁶

Rather than view the performance of supply chains from the perspective of disruption, a distinction between the resilience and robustness of supply chains should be made, while also noting the ability to redirect products to new supply chains. Resilience relates to the ability of supply chains to return to normal operations after the disruption in a reasonable period of time. Robustness is the ability of supply chains to continue operations during a crisis.¹⁷ Redirecting goods relates to the ability of producers to shift from one supply chain to another for essential products.

The experience of Hyundai’s plants in South Korea is one of resilience. Within a relatively short period of time, operations were able to return to normal. Samsung’s ability to shift production of some smartphones to factories in Vietnam after an outbreak of COVID-19 in its South Korean factory reflects robustness. The challenges to keep shelves stocked with food and toilet paper early in the crisis are related to the ability to redirect products from commercial to consumer supply chains. According to one survey of supply chain managers in the United States, 78 percent of supply chains were disrupted by the pandemic.¹⁸ Increased demand left grocery stores short of items such as canned food and pasta, while toilet paper was difficult to find at grocery stores and department stores. The challenges of these industries were more related to increasing demand or an inability to switch products from one supply chain to another.

The food supply chain has held up relatively well. While there were some closures of meat packing plants in the United States, farmers and ranchers who sold products to restaurants had difficulties redirecting their supplies to consumer markets. Faced with no market for their food despite emptying shelves at grocery stores as Americans redirected their consumption of food from restaurants to homes, usable food was destroyed.¹⁹ But, on the whole, food supply chains were resilient. In the case of toilet paper, “just-in-time” production meant that there were not significant enough amounts in warehouses to meet demand. Prior to the pandemic, production of toilet paper was at 92 percent of machine capacity. In March, that increased to 99.9 percent.²⁰ Excess toilet paper was available, but unused, at restaurants, hotels, and office buildings.²¹

The pandemic has also resulted in supply chain disruptions from increased demand rather than supply disruption. In the initial months of the pandemic, social distancing measures and concerns over the pandemic resulted in a drop of over 90 percent for restaurant reservations on OpenTable by March 18, 2020.²² As consumers shifted from dining out to eating at home, demand for prepackaged food increased fivefold. The shift to working at home and the increased need to disinfect products and surfaces to protect against COVID-19 resulted in a similar level of demand for household supplies.²³

With businesses and schools moving to remote work to comply with stay-at-home orders, there was an increase in demand for consumer electronics such as PCs, game consoles, monitors, smartphones, and other electronic products. The increase in demand went beyond what semiconductor manufacturers could produce. As a result, some automotive companies had to suspend production due to chip shortages, but Apple and Sony suggested that increasing demand resulted in shortages for their products as well.²⁴

While increased demand for consumer electronics and automobiles has resulted in a supply shortage for the automotive industry, the trade war with China has also played a role. When the Trump administration blacklisted Huawei, the company began to stockpile semiconductors, taking up potential supply. The decision to also blacklist China's Semiconductor Manufacturing International (SMIC) resulted in further supply constraints. At least one automaker switched its sourcing of semiconductors to Taiwan Semiconductor Manufacturing, which was unable to meet the demand with other companies looking to switch suppliers²⁵ or stockpile chips over concerns regarding the new export controls.²⁶ The pandemic has exposed a mismatch between how supply chains for the automotive industry and semiconductor industry work. The automotive industry has developed a "just-in-time" model to minimize inventories, but the semiconductor industry requires a more managed relationship due to the time needed to scale up inventory risks for semiconductor producers or maintain excess inventory of their own.²⁷

Increasing demand has also impacted the pharmaceutical industry, wherein the effort to ramp up production of vaccines is causing supply disruptions for other drugs. While the use of the Defense Production Act has ensured that vaccine makers have access to the ingredients and production space that they need, it has left a shortage of equipment, production lines, and ingredients in the case of some other drugs,²⁸ although drug shortages in the United States date back at least two decades.²⁹

In the area of medical products, it is less conclusive that supply chains broke down overseas. China accounts for more than 50 percent of the world's imports of critical personal protective equipment such as protective garments, surgical and respirator masks, and medical goggles.³⁰ It is also the world's second largest source of active pharmaceutical ingredients (API) after the United States. An analysis by Avalere found that 54 percent of the APIs used in finished pharmaceutical products are in the United States.³¹ Despite being the world's second largest source for APIs and the third largest for the United States, China accounts for only 6 percent of the APIs in medicines consumed by Americans. Ireland instead is the second largest source for APIs and accounts for 19 percent.³²

Additionally, because pharmaceutical production is a capital intensive industry, offshoring of production for high quality pharmaceuticals has been driven more by the tax structure in the United States than production costs abroad, with Ireland and Switzerland being two of the beneficiaries.³³ Logistics have also played a role. Social distancing rules have created backups not just in ports, but also along the full intermodal system.³⁴

Biden Administration Policies on Supply Chains and Reshoring

Joe Biden was elected president on a campaign to deal with the pandemic, “Build Back Better,” and restore America’s relations with allies. As part of that pledge, Biden called for increased support for manufacturing in the United States and the return of critical supply chains.³⁵ Since taking office, the Biden administration has prioritized restoring U.S. manufacturing and securing supply chains, not dissimilar from the Trump administration. Its Interim National Security Guidance commits to prioritizing U.S. economic recovery from the pandemic including through investments in national competitiveness and securing critical supply chains.³⁶

Trade policy would normally be an important part of an administration’s efforts to develop resilient supply chains, but that may not be the case in the Biden administration. While the Trade Policy Agenda released by USTR, prior to USTR Katherine Tai’s confirmation, notes that the trade agenda is a key component of the recovery from COVID-19 and says that “Central components of the 2021 trade agenda will be the development and reinforcement of resilient manufacturing supply chains, especially those made up of small businesses, to ensure that the United States is better prepared to confront future public health crises,”³⁷ the early decisions on supply chains have occurred without significant involvement by USTR.

The administration has also been slow to develop a trade policy, and there are indications that national security and domestic policy will play a larger role in the decision-making process. Three weeks into the Biden administration, officials acknowledged off-the-record that trade priorities were still being discussed within the administration, and used talking points such as “Trade policies that support and benefit American workers are what you’ll likely see her [USTR Katherine Tai] bring to the job.”³⁸ Tai’s confirmation was not a priority, and the opening statement of her confirmation hearing did little to go beyond talking points about strengthening relations with allies and boosting resilience.³⁹

In contrast, Biden has made clear in his own remarks that the policy will be shaped more by geostrategic concerns about China and domestic considerations than the pandemic itself. In remarks at the Department of Defense, he announced that the department will be taking the lead on a China policy review of the key priorities for dealing with China, including technology.⁴⁰ These reviews may result in a shift from “decoupling,” which is likely an unachievable policy, to a more nuanced “small yard, high fence” policy focused on a limited number of areas.⁴¹

Supply chain issues are also part of the Quad’s Critical and Emerging Technology Working Group,⁴² including in semiconductors and rare earths, areas where the Biden administration appears to be building on the cooperation begun under the Trump administration.⁴³ The nature of the Quad as a counterweight to China, also, suggests that national security rather

than tech or trade policy is driving collaboration on the issue for the Biden administration in much the same way as it did in the Trump administration. The administration has also indicated that it is not looking to remove the Trump administration's tariffs in the near future, further underscoring its geostrategic focus on China. In Tai's first remarks after her confirmation, she suggested that the administration is unlikely to remove tariffs unless it receives something in return.⁴⁴

Domestic considerations are also at play. In signing an EO to review critical supply chains, Biden said, "Resilient, diverse, and secure supply chains are going to help revitalize our domestic manufacturing capacity and create good-paying jobs, not \$15 an hour—which is what we need to do someday. And sooner is better, in my view. But jobs that are at the prevailing wage."⁴⁵ The EO consists of two major components. The first is a 100-day review of vulnerabilities in supply chains for APIs, rare earth minerals, semiconductors, and large capacity lithium ion batteries. The second component is a year-long review of supply chains for agriculture and the industrial bases for information and communications technology, defense, energy, public health and biological preparedness, and transportation. This longer review will identify key risks for these areas and provide recommendations to improve supply chain resiliency.⁴⁶

While the reviews will include the departments of Defense, Commerce, Energy, Health and Human Services, Transportation, and Homeland Security, they do not appear to have a role for USTR, suggesting the focus on supply chains will be geared more towards building domestic capacity than ensuring that trade policy supports resilient supply chains.

The Biden administration's report after its initial 100 day review demonstrates some of these tensions between working with allies within existing supply chains and promoting the development of domestic production. The report understandably focuses on the steps the United States can take to promote production domestically, such as the use of government funds and purchases to support domestic manufacturers. However, despite acknowledging that "To ensure resilient supply chains, it is essential that they be globalized" and that the United States will be unable to produce all critical components domestically, its recommendations on trade policy and cooperation with allies are less focused. On trade policy, the recommendations are largely confined to the need for trade enforcement and the consideration a Section 232 national security investigation into imports of neodymium magnets. In regard to allies, the report calls for engaging allies on supply chain vulnerabilities and hosting a presidential summit, but perhaps most substantively also recommends that the U.S. Development Finance Corporation be utilized to support the development of secure supply chains abroad.⁴⁷

In addition to the supply chain review, the Biden administration has dedicated funding to address some of these issues in its infrastructure proposal, the American Jobs Plan. The infrastructure proposal calls for \$50 billion to support manufacturing and research and development of semiconductors, as well as funding for research into the separation of rare earth elements, and pharmaceutical ingredients.⁴⁸

Biden also signed an EO to strengthen the "Buy American" provisions for government procurement,⁴⁹ but this may have limited impact unless the administration withdraws from the WTO's Government Procurement Agreement and renegotiates provisions in U.S. FTAs related to government procurement.

Congressional Supply Chain Initiatives

Congress has also played an active role in addressing concerns over the security of critical U.S. supply chains. The exposure of U.S. supply chains to China initially brought the issue to the attention of Congress,⁵⁰ but the functioning of supply chains during the pandemic also became an issue for it. In the 116th Congress, which ended in 2020, attention largely focused on supply chain issues related to semiconductors, rare earth minerals, and pharmaceutical and medical supplies.

Semiconductors are critical components of modern economies, playing a crucial role in everything from smartphones to heated seats in vehicles. They are also critical to the emerging technologies that are likely to drive technological development in areas ranging from self-driving vehicles to artificial intelligence and advanced defense technologies. For these reasons there is a strong interest in maintaining U.S. and allied dominance. The current semiconductor supply chain is largely controlled by the United States and its allies. The United States accounts for 39 percent of the total value in the global supply chain for semiconductors, while its allies account for 53 percent.⁵¹

To strengthen this sector, the 116th Congress included the Creating Helpful Incentives to Produce Semiconductors for America, or “Chips for America,” Act in the 2021 National Defense Authorization Act. The legislation would support the semiconductor industry in three significant ways. First, it establishes a new program at the Department of Commerce to incentivize investment in facilities and equipment in the semiconductor industry in the United States. Second, it authorizes the Secretary of Defense, in coordination with other departments, to establish a public-private partnership to ensure the production of the microelectronics necessary for equipment critical for national defense. Lastly, it attempts to address the allied dimension of the semiconductor supply chain by establishing the Multilateral Semiconductors Security Fund to provide a co-funded source for the United States to work with allies to align policies and develop secure semiconductor supply chains.⁵²

The pandemic, however, has also brought the role of supply chains for pharmaceuticals and medical devices to the attention of Congress as the United States dealt with shortages of personal protective equipment and pharmaceutical products. As the first wave of COVID-19 hit, a Johns Hopkins report estimated U.S. PPE needs for the first hundred days and found that the United States would require 3.393 billion gloves, 321 million isolation gowns, 179 million medical grade masks, and 57 million N95 or similar respirators.⁵³ With critical supply chains for these items located in China, the United States was unable to meet the growing demand.

Prior to the pandemic, China accounted for 48 percent of U.S. imports of PPE. In areas such as face masks the figure was 70 percent of U.S. imports. While it was not as large a source of imports for some other products, it still accounted for 42 percent of protective garments and 38 percent of gloves.⁵⁴ But Chinese restrictions on exports of face masks and its efforts to import more from the rest of world placed strains on efforts by the United States to meet its needs.⁵⁵

Addressing these challenges requires a deeper understanding of U.S. medical supply chains. As part of the Coronavirus Aid, Relief, and Economic Security (CARES) Act, Congress included provisions to help gain a better understanding of medical supply chain issues in the United States. It expanded reporting requirements to help better understand the finished drugs and APIs produced in the United States, for drugs facing shortages; required the FDA to maintain a list of shortages of medical devices; required risk management plans from certain pharmaceutical manufacturers; and tasked the National Academies of Science, Engineering, and Medicine to study the security of U.S. medical devices and pharmaceutical supply chains.

One effort to focus more production in the United States, the U.S. MADE Act of 2020, would have prohibited the use of federal funds to purchase PPE for the Strategic National Stockpile from foreign sources and created a 30 percent tax credit for qualifying PPE manufacturing projects. It did not gain traction in the 116th Congress and has yet to be reintroduced in the current Congress.

In the 117th Congress, the American Rescue Plan provides \$6 billion to support the supply chain related to COVID-19 vaccines and \$500 million for the FDA to conduct oversight of supply chains related to the pandemic. The legislation also provided \$10 billion to support the purchase and production of PPE and vaccines through the Defense Production Act of 1950. While the American Rescue Plan provides support to address immediate supply chain constraints, Congress has not yet taken up legislation to address longer-term medical supply chain issues.

Rare earth minerals have also been an area of focus for Congress. These minerals are necessary for many electronics and defense components, and the United States has become dependent on China for their supply. China is estimated to account for upwards of 85 percent of the production of rare earth minerals and 80 percent of U.S. imports of rare earth minerals.⁵⁶ The 116th Congress introduced a series of bills that took different approaches to the issue. Some would establish tax incentives or Defense Department grants for the extraction of rare earth minerals, while other legislation focused on research or the recycling of rare earth minerals.

In the current Congress, some initial legislation looks at supply chains more broadly. Senators John Cornyn and Christopher Coons introduced separate bills related to securing supply chains. Senator Cornyn's bill, S.849, would require the director of the CIA and the director of National Intelligence to conduct a study to identify critical supply chains for national security. Coons' legislation, S.869, would establish an office in the Department of Commerce to manage relations with state and local governments and the private sector on supply chain preparedness.

The Challenge in Moving Supply Chains

Economic interests have driven the development of supply chains, and adjusting them to place a greater emphasis on national security will be difficult. From 2000 to 2017, significant changes took place in global value chains. China replaced Japan not only as a traditional trade hub, but also in the subfield of ICT. At the same time, trade became more regionalized and U.S. linkages with the rest of the world declined.⁵⁷ As production has shifted around the world, it has also been driven by the increasing complexity of parts. Production is no longer done by vertically integrated firms, but by a series of specialists who provide parts. Even something as seemingly simple as an LED lightbulb requires suppliers with unique skill sets.⁵⁸

China's infrastructure and specialized producers have made it central to modern production. The quick pace at which it was able to restore its economy during the pandemic and its status as the world's second largest economy will further deepen the reluctance of firms to shift supply chains away from China, although some will opt for the China-plus strategy to provide some robustness to their supply chains and ensure that they are able to serve both the U.S. and Chinese market. For firms that shift supply chains away from China, the pandemic has not been the primary motivation. Early in the pandemic, 33 percent of U.S. firms in China were considering moving supply chains, but increased costs from the trade war's tariffs were the primary reason. Fifty-eight percent were also concerned that more resilient supply chains would result in increased costs.⁵⁹ A more recent survey by the American Chamber of Commerce in China found a similar percentage of firms planned to reduce or maintain their current level of investment in China; on the whole, 81 percent of firms expect economic conditions in China to improve this year.⁶⁰

Costs will remain an issue for firms. A Bank of America study found that moving all foreign supply chains out of China would cost \$1 trillion over five years.⁶¹ That does not include the increased long-term costs from moving to developed markets where costs are higher. In the semiconductor industry, for example, the total 10-year cost of a new factory is 30-50 percent higher in the United States than other countries. An estimated \$20-\$50 billion in federal grants and tax incentives would be needed to equalize costs.⁶² In recent years there has been a trend towards moving some production away from China to Southeast Asia. The Kearney China Diversification Index suggests that production has been moving there over a series of years, and it has been accelerated by the U.S.-China trade war. However, Kearney notes that there is also evidence of transshipping Chinese goods through countries such as Vietnam. There are limits, however, to this shift. Firms looking to move production to Southeast Asia would lack access to the same quality of infrastructure they find in China and would need to either bring suppliers with them or move production back in-house.⁶³ Securing new suppliers would require going through an extended process to certify that their parts meet required standards for final products.

Prior efforts to move supply chains have had only partial success. An early example is Japan's efforts to reduce its dependence on China for rare earth minerals, China's dominance of which became an issue after a diplomatic dispute with Japan in 2010. At the time, China produced 97 percent of the world's rare earth minerals. Rare earth minerals are critical to the production of consumer electronics and the defense industry, and there was and remains significant interest in establishing other sources of production. The Japanese

government and Japanese companies invested in mining projects in other countries. As a result, the Australian firm Lynas is now the world's largest producer of rare earth minerals.⁶⁴ However, despite support from the Japanese government and increased investment by companies after 2010, China still controls an estimated 85 percent of the production in rare earth minerals and accounts for 56 percent of Japan's imports.⁶⁵ A decision by the Pentagon to fund production for defense purposes may help further reduce Chinese dominance, but low prices, high startup costs, and environmental concerns have helped China maintain a significant majority of the production.

Another challenge will be building confidence in new supply chains in critical industries such as medical supplies. According to the WTO, as of March 30, 2021, there have been 285 export restrictions placed on trade in goods.⁶⁶ Some of the most noteworthy have included France and Germany's initial export ban early in the crisis, on exports of PPE to other EU member states such as Italy and Spain.⁶⁷ While the United States does not have export controls, its use of the Defense Production Act has disrupted the export of raw materials used in vaccine production and distribution as firms are required to fulfill U.S. government orders before exporting any additional production. This has resulted in supplies being tied up in the United States rather than going to a country like India with a greater immediate need.⁶⁸

With the rollout of vaccines to inoculate populations against COVID-19 new restrictions are being put in place. The United States and the United Kingdom both have the ability to block the export of vaccines, while the EU established an export control regime in early 2021 that required vaccine producers to seek authorization for the export of vaccines and allowed member states to block exports if contractual obligations are not being met. In March, Italy became the first country to use the new export regime when it blocked the export of 250,000 doses of the AstraZeneca vaccine to Australia.⁶⁹

Developing secure medical supply chains is about the ability to produce specific products. There have been shortages of the raw ingredients needed to produce vaccines and specialized plastic bags needed in the production process.⁷⁰ It also requires the ability to produce the products needed to deploy vaccines and other medical goods. A specific type of needle is required to vaccinate populations. While the United States is already the world's largest producer of syringes, it faces a shortage of the needles necessary for vaccinations.⁷¹ Developing secure supply chains of medical products requires thinking through the supply chain of mundane components and how a vaccine would be deployed. Without sufficient products such as needles for inoculations, a secure vaccine production supply chain has limited value. It would not be cost effective for the United States or other countries to move towards production of all medical supplies, or other critical inputs, domestically. Instead, steps need to be taken to ensure that the proper procedures and trust are in place to allow supply chains to function properly.

Critical components in the supply chain may also not be identifiable until a crisis occurs. Prior to COVID-19, mRNA vaccines were not FDA-approved for any disease,⁷² but now they have become one of the more successful ways to vaccinate against COVID-19. However, they require suspending the genetic materials in the vaccine in lipid nanoparticles. These specialized particles are produced by only a small number of firms in the United States, Canada, and Austria.⁷³ It is unlikely that prior to the pandemic lipid nanoparticles would have been identified as critical components in the supply chain.

Recent events in Texas highlight why reshoring production will not necessarily build resilience and could instead increase risk to supply chains. In February of 2021, an Arctic blast sent extreme cold weather south covering all of Texas and straining power systems. To maintain power to homes and hospitals, factories in Texas had to suspend operations. This affected production at Samsung's semiconductor factory outside of Austin and chemical plants along the Gulf Coast. The suspension of production at Samsung's facility further strained the already challenged supply chains for semiconductors. The facility accounts for 5 percent of global semiconductor production and has been idled for more than a month,⁷⁴ raising concerns about the spread of the semiconductor shortage from automobiles to smartphones and PCs.⁷⁵ The same storm has idled chemical plants as well creating shortages for plastics across a range of industries, including for medical supplies such as PPE.⁷⁶

As the effects of climate change become more common, the probability of extreme weather that could disrupt production will become another consideration for the location of supply chains. Moving supply chains is about more than moving production. In the case of some products, such as semiconductors, a small number of firms specialize in the production of key chemicals or components. This issue came to the fore when Japan decided to place export restrictions on three key chemicals necessary for semiconductor production in South Korea in 2019. Photoresists, for example, are produced by only a small number of companies, and 90 percent are believed to be produced in Japan. South Korean semiconductor firms Samsung and SK Hynix were dependent on Japan for supplies.⁷⁷ To resolve this issue the South Korean government has invested in developing domestic capacities,⁷⁸ while some Japanese firms have moved production to South Korea.⁷⁹ South Korea is still working towards developing a domestic semiconductor supply chain.

With a significant portion of the world's semiconductor production in South Korea and Taiwan, the United States will need to calculate the geopolitical risk of China's relations with each and how that may affect access to semiconductors for U.S. businesses and allies. Senator Marco Rubio has pointed out a similar issue in the case of rare earth minerals. Even if the United States is able to increase the mining of minerals, if it is unable to also spur additional refining capacity it will still need to send minerals to China for refining.⁸⁰

Systems for procuring goods also need to be considered. In addition to the challenges of agricultural producers in switching supply chains, the efforts of U.S. companies and entrepreneurs to expand domestic production of face masks during the pandemic highlights some of the challenges of returning production to the United States. Initially, production by established domestic suppliers was not enough to meet demand. However, as new production came online from new market entrants, state governments, hospital systems, and medical supply distributors stuck with established suppliers, despite at least one new U.S. producer being price competitive.⁸¹ Many of these firms are now struggling financially and face the closure of their businesses. In the absence of a longer-term strategy that combines government purchases with loans and subsidies, new firms that enter the market to increase U.S. domestic production will likely fail to gain market share while the economic incentives will continue to favor imports rather than expanded domestic capacity by established firms.⁸²

Options for the United States

The impact of the pandemic on supply chains for medical equipment, the subsequent semiconductor shortage, and the grounding of a cargo container ship in the Suez Canal have all highlighted the risks of global supply chains, but concentration of supply chains in one location brings its own risk. The growing geopolitical contest with China is pushing the United States to reexamine the security of supply chains for critical components. In doing so, the Biden administration should consider stockpiling, additional funds for research and development, international trade, and technology to better secure U.S. supply chains.

Stockpiling

The pandemic and prior natural disasters have demonstrated how natural events can disrupt supply chains. Stockpiles of medical supplies and parts can help healthcare systems and firms whether or not the disruption to supply chains is from natural events. The modern Strategic National Stockpile was originally authorized in 1998 as the National Pharmaceutical Stockpile. At the time, it was designed to create a reserve of vaccines and pharmaceuticals to prepare for chemical or biological attacks, as well as widespread disease. In 2003 it was renamed the Strategic National Stockpile and expanded to warehouse supplies of other medical necessities such as PPE.⁸³

The Strategic National Stockpile failed during the pandemic because a series of administrations and Congresses underfunded the reserve and failed to replenish supplies that were used during the outbreak of H1N1.⁸⁴ With the experience of a modern pandemic there should be a better understanding of certain supply needs for the Strategic National Stockpile. But if the goal is to move towards supporting more U.S. manufacturers the government may need to consider joint purchasing contracts with private medical providers that follow “Buy American” procedures and transfer perishable products over time to the private sector. This could also help address the tendency to defund stockpiles as a crisis fades from memory.

The production slowdowns in the automotive sector demonstrate the need for stockpiling as well. While firms have been able to quickly shift into the production of facial masks,⁸⁵ items such as semiconductors require significant expense and time to add production. TSMC, the world’s largest contract semiconductor producer, for example, plans on constructing a new facility in Arizona. Construction is expected to begin in 2021 with a total investment of \$12 billion. Production is expected to begin in 2024.⁸⁶

While stockpiling components creates resiliency, it also comes with a financial burden for firms. Apple recently cut production of its iPhone 12 mini when sales did not meet expectations.⁸⁷ The “just-in-time” model reduces the financial burden of production changes of this kind by reducing stock on hand that might now not be used due to the changes in production from declining sales or the need to update a product with a new version of a component, as in semiconductors where advancements take place relatively quickly. The Biden administration’s proposal for the federal government to provide purchase guarantees for critical minerals in its 100 day supply chain review could be one option, but some costs may need to be addressed through the introduction of tax credits to encourage stockpiling of critical components by the private sector.

Research and Development

Discussion of supply chains should not be viewed in a static manner related to today's products, but rather in the context of a fluid technological mix. As new technologies emerge related to renewable energy, electric vehicles, and autonomous technologies, supply chains for these products will initially develop around the locations where new products are developed and existing supply chains can meet new demands. If the United States is unable to maintain its technological edge and innovative capacity, supply chains for future market leading products will, over time, gravitate to new markets.

At the moment, the United States is still the world's largest source of funding for research and development (R&D), but China has been rapidly closing the gap. After the global financial crisis U.S. federal investment in R&D declined in real terms through FY 2015. While federal funding has resumed increasing, and total U.S. R&D is expanding, China's R&D is growing at a rate three times higher than the United States.⁸⁸ Despite the recent growth in federal funding for R&D, federal funding as a percentage of U.S. R&D is declining.⁸⁹ Viewed as a percentage of GDP, moreover, federal funding for R&D has been declining since the mid-1960s.⁹⁰ The result is that the United States is no longer seen as the uncontested leader in science and engineering.⁹¹ Federal funding for R&D plays an important role in basic research, and hence in the development of new technologies that drive the U.S. economy. Reversing some of that decline in R&D should be a part of any plan to secure U.S. supply chains going forward.

Better Integrating Trade Policy into Supply Chains

Trade policy has an important role in securing supply chains. Not all production will be returned to the United States as trade has been moving towards more regional production since prior to the pandemic. Additionally, doing so would create its own risks for supply chains, as the winter storm in Texas demonstrates. But there have also been clear failures of policy in international supply chains that need to be addressed in order to restore confidence. South Korea's experience with Japan's trade restrictions demonstrates why robust trade rules are necessary, even among allies, to secure the flow of critical goods.

The WHO, European governments, and other governments have called for a new treaty to ensure that in future pandemics there is equitable access to vaccines, medicines, and diagnostics,⁹² a challenge in the current pandemic with governments placing export controls on critical items. Whether it is embracing a new treaty to deal with a future pandemic, or a version of the Trump administration's clean networks approach, securing supply chains requires working with allies and partners to establish rules and regulations that ensure that critical goods flow in a future pandemic or that critical technologies remain secure. The Biden administration's 100 day supply chain review's recommendations on trade enforcement should only be the beginning of discussions on trade policy's role in securing supply chains.

Utilize Technology to Improve Supply Chains

While the Biden administration may want to return supply chains to the United States, it should also consider using technology to improve the robustness of supply chains. Artificial intelligence and cloud-based services can help firms to better monitor and redirect supplies during future disruptions, while additive manufacturing and smart factories could allow for

smaller and more flexible production facilities.⁹³ Technology can help in other ways. One of the lessons from the pandemic has been the need to social distance and undertake proper procedures to prevent the spread of COVID-19 in production facilities. Automation would help to remove some of the human element from the production process, but it would also run counter to the administration's goal of supporting job creation with the return of manufacturing jobs.

As the United States examines its supply chains and considers next steps on how to secure them, it will also need to avoid fighting the last battle. The Strategic National Stockpile was unprepared to handle the pandemic because of a focus that remained on the threat from terrorist attacks.⁹⁴ If the United States becomes too focused on the pandemic itself or certain industries, Washington might again find itself unprepared for the challenge it will face. Instead of looking to secure supply chains through an emphasis on reshoring, it should be looking to increase flexibility so as to provide more options for firms and policy makers during the next crisis.

Despite the concerns about the pandemic, it is national security and economic concerns rooted in China's rise that are driving U.S. views on supply chains and technology. The Trump administration may have initiated a more assertive stance towards China, but the Biden administration has so far shown few indications of adjusting many of the policies the Trump administration put in place. With policy being driven by concerns over U.S. supply chains in China, it needs to focus more on international cooperation. There is a tension in a policy designed to return supply chains to the United States while trying to increase cooperation with allies and partners. China is already the top trading partner for many countries, and a policy that is overly focused on the United States risks increasing China's influence internationally, at worst, and reducing economic growth and access to goods for developing countries, at best.

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