Office of the Comptroller of the Currency

ON POINT

ECONOMIC AND POLICY ANALYSIS FROM THE OCC

Supply Chain Vulnerabilities Likely to Persist

After two years of substantial supply chain stress, new shocks emerged out of country-specific events in 2022. China imposed extensive lockdowns consistent with the country's zero-COVID-19 policy, disrupting production and logistics. The Russian invasion of Ukraine has had even greater consequences, most prominently in the European gas markets, but also through supply chain disruptions in agricultural, automotive, and other industries. Highly specialized global supply chains can result in greater efficiency and lower costs, but the concentration of production in a few countries also increases exposure to local geopolitical, physical, and other risk events. Depending on the relative concentration and importance of a product in global supply chains, country-specific shocks affecting that product can have global effects.

Concentration Risk Is Prevalent, but Linkages Matter

By many measures of market concentration, exports of numerous products are highly concentrated. At the most extreme, there are roughly 200 products for which 75 percent of global exports come from just one country.[1] Concentration is not a new feature of supply chains. Over the last 25 years global trade flows grew twice as fast as gross domestic product (GDP), as supply chains became increasingly globalized. However, country export concentration for products on average remained relatively stable during that period (figure 1).[2] Exports for some industries, such as food, became more diversified by country during that period. Exports for other industries, such as electronics and electronic parts (which include semiconductors), became increasingly concentrated by country, as trade in those specific industries became centered in East Asia.

Export concentration alone does not imply significant supply chain risk; the interlinkages and overall complexity of the supply chain are also factors. Some of the products with the greatest concentration of exports include jute fiber (with exports primarily from Bangladesh), silk (China), and cork (Portugal). However, these products offer modest risk to global supply chains as they

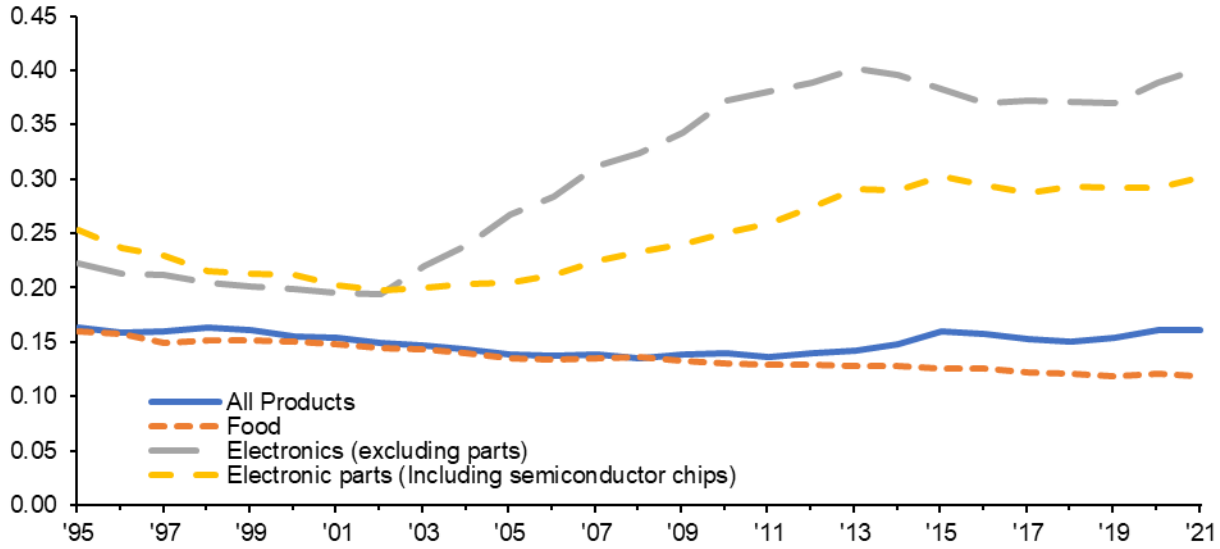
[1] McKinsey, "Risk, Resilience, and Rebalancing in Global Value Chains," August 6, 2020.

[2] As measured by the Herfindahl–Hirschman Index (HHI). The HHI is a concentration measure used in antitrust assessments. It is calculated by summing the squared market share (or export share) of every firm (or exporter): $HHI = \sum_{i=1}^{N}(MS_i)^2$

have limited industrial usage. In contrast, oil production is more diversified among many exporting countries, but small changes in production can have a significant effect on price, and large downstream effects, because oil is a critical economic input.

Figure 1: Export Concentration Is Stable for Products Overall, But Increasing for Electronic Products

Export market concentration
Herfindahl–Hirschman Index, normalized



Source: United Nations Conference on Trade and Development UNCTADStat

Note: A high HHI indicates that the market is dominated by only a few suppliers, while a low HHI indicates that the product has well-diversified production or exports.

The location of production leads some industries to be more exposed to certain risk events. A McKinsey study[3] finds that flooding risk is greatest for the apparel and textiles industries, with production and supply chains located in countries susceptible to floods, such as China, Bangladesh, and Vietnam. While not considered by the McKinsey report, geopolitical risk events may be especially relevant for mining metals given their concentration in emerging markets. Chile and Peru account for 37 percent of global copper production, Indonesia produces a quarter of the world's tin, and Russia accounts for about a fifth of the global production of Class 1 nickel, which is used in electric vehicle batteries. Other metals have significant production concentrations in countries with histories of conflict or political unrest. The Democratic Republic of the Congo produces nearly 70 percent of the world's supply of cobalt despite persistent military conflicts within its borders. South Africa, which recently saw violent domestic protests, is a major producer of chromium, manganese, palladium, and platinum.

Production location is not the only relevant factor. The interlinkages and product complexity in the semiconductor supply chain leave it particularly exposed to potential trade disputes. Semiconductor manufacturing tends to be more concentrated than the average product, with about 75 percent of chip production based in East Asia (including China). Production of specific chip types is even more geographically concentrated; Taiwan produced 92 percent of the most advanced logic chips (defined as being less than 10 nanometers in diameter) in 2020, and

[3] McKinsey, "Risk, Resilience, and Rebalancing in Global Value Chains," August 6, 2020.

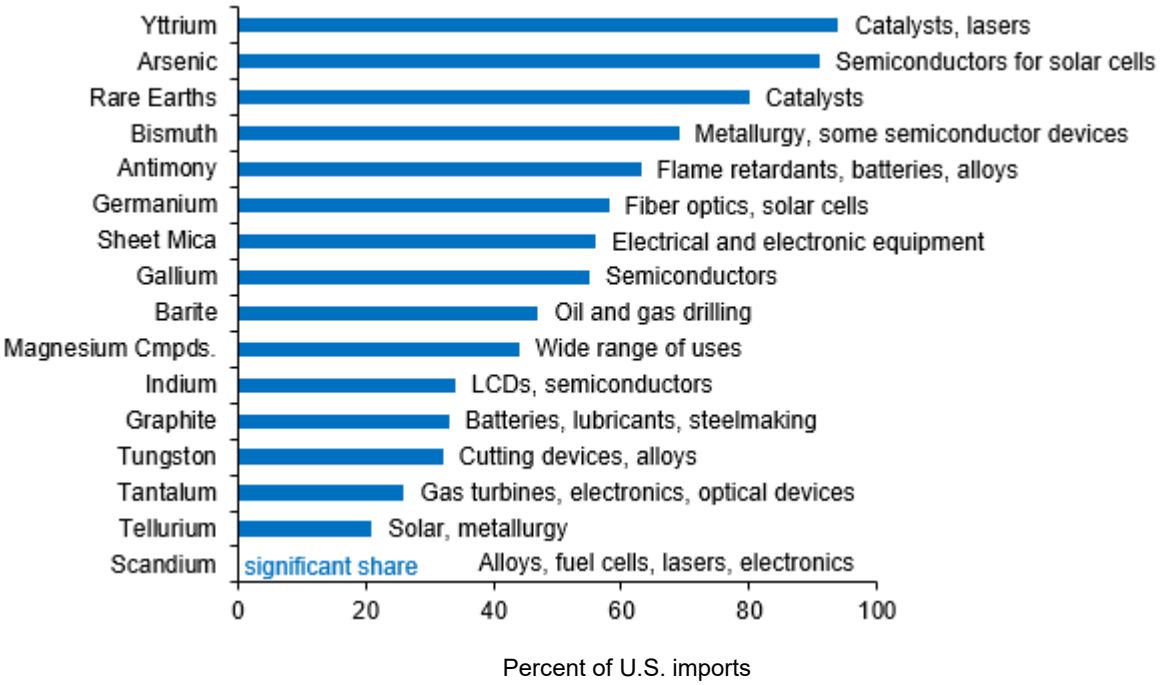
South Korea produced the remaining 8 percent.[4] Though these advanced logic chips represent only about 2 percent of global chip production, the concentration of such a strategically important technology input has been cited as a potential national security risk[5] and prompted increased U.S. government support for domestic chip production. Nevertheless, the complexity of chip products promotes specialization in the industry. The lithography machines necessary to produce advanced logic chips are solely produced by one Dutch firm, ASML.

China Is a Unique Country Concentration Risk

China accounts for more concentration risk than any other country. Of all the instances in which one country accounts for 75 percent of product exports, China accounts for more than half. China's significant market share of many products creates dependencies for many manufacturers. The United States relies on imports primarily sourced from China for some strategic minerals (figure 2). China's position as a key materials supplier enabled China to vertically integrate many supply chains. China sources cobalt, nickel, and lithium from strategic partners, allowing it to produce about two-thirds of the world's lithium-ion batteries. The same structure exists for many green products, potentially increasing dependence on China as green technology adoption accelerates.[6]

Figure 2: The U.S. Relies Heavily on China for Many Minerals Used For Key Products

Chinese share of selected minerals with U.S. import dependence greater than 50 percent



Source: U.S. Geological Survey

[4] Boston Consulting Group and Semiconductor Industry Association, "Strengthening the Global Semiconductor Supply Chain in an Uncertain Era," April 1, 2021.

[5] White House, "Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth," June 2021.

[6] European Commission, "Critical Raw Materials for Strategic Technologies and Sectors in the EU - A Foresight Study," February 9, 2020.

Product concentration risk in China also extends to industries in which China is not a dominant player. China is central in the electronics trade even when semiconductor chips are produced elsewhere. China accounts for over half of the world's exports of mobile phones and more than 70 percent of the world's exports of personal computers. While China accounts for a relatively small part of global pharmaceutical output, it is a major supplier of active pharmaceutical ingredients used in many pharmaceuticals.

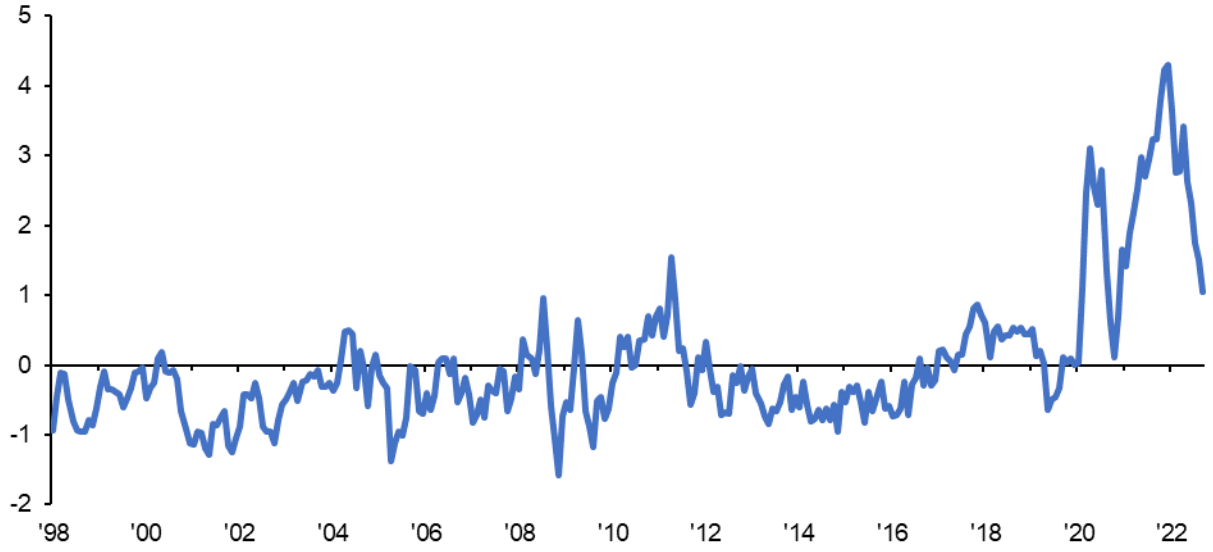
Mitigating Supply Chain Risks Is Difficult

Many firms have indicated they will revise supply chain management practices to promote greater resilience, even at greater cost.[7] For some firms, this may include diversification of suppliers by country and increased "nearshoring," locating production closer to home markets. "China plus one" models, where currently Chinese-dependent firms would add a non-China supplier, are also frequently discussed.

Diversification of suppliers can improve supply chain resiliency, but supply chains will still be at risk from the systemic issues experienced during the pandemic, such as disruptions to global logistics networks or difficulties projecting customer demand. Localized risk events typically have a more limited impact than the type of systemic shocks seen during the pandemic. For example, the 2011 Tōhoku earthquake and tsunami in Japan affected key links in global supply chains. The drop in semiconductor shipments after the earthquake exceeded the decline after the initial March 2020 lockdowns. Yet despite its severity in Japan, measures of global supply chain stress (figure 3) at their peak after the Tōhoku earthquake were about a third of those at the end of 2021.

Figure 3: Current Supply Chain Disruptions Far Exceed Those After the 2011 Tōhoku Earthquake

Global Supply Chain Pressure Index
Standard deviations from average value



Source: New York Federal Reserve

[7] McKinsey, "Risk, Resilience, and Rebalancing in Global Value Chains," August 6, 2020.

There are other factors that may limit the extent of diversification. Mining is one example, where the availability and accessibility of minerals often dictate production location. Shortages emerged in products that are sourced locally, such as lumber for home construction. In other industries, like semiconductors, product complexity may strongly encourage specialization.

There are some signs that public policy will be a key determinant on how supply chains realign. For certain minerals, batteries, semiconductors, and other high-tech products, strategic considerations may be more impactful in reshaping supply chains than economic aspects. But in many industries, concentration risk will continue to exist. Supplier diversification will be part of a broader strategy by firms to improve resilience. The strategy would also include accelerated innovation that could facilitate substitutability of key inputs, gaining greater visibility of suppliers, and maintaining larger input and product inventories to manage the supply chain disruptions that occur.

The Point?

Industries dependent on specialized raw materials, highly specialized technological processes, and some specific countries likely will continue to face supply chain vulnerabilities in the medium term.