

# The Complexity of the Supply Chain

BY MICHAEL MANDEL

*We need a new  
approach to assess  
supply chain resilience.*

“Supply chain disruption” is suddenly a widely searched term on the internet. As store shelves are inexplicably bare, automobile production is slowed by a lack of semiconductor chips, and inflation accelerates, both consumers and economists are looking for answers. But answers are hard to come by. Conventional trade and economic statistics tell us very little about the dynamics of global supply chains which have become so important to the global economy. We may have to do a lot more digging before we understand how to buttress our resilience to future disruptions.

The classic picture of international trade taught in economics textbooks is based on “arms length” transactions. A wine merchant based in Washington, D.C., for example, will contract to buy one hundred bottles of Bordeaux from a French distributor. Or an Ohio-based manufacturer will browse an online catalog and buy ten thousand screws of a particular size from a Guangdong factory.

But for the most part, international trade is not as simple as opening up a paper or online catalog and ordering a pre-made product, at a fixed price. Most large retailers and manufacturers can’t just buy generic goods off the world marketplace and expect to have the quantities and products that they want. For “simple” goods like apparel and toys, a retailer like Walmart will have in-depth real-time knowledge of what styles, colors, and materials customers are buying, and work with suppliers around the world so that they can plan ahead. In other words, market data flows from domestic buyers to overseas suppliers even before production.

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The cross-border flow of data is even more important for more complicated items like cars and smart phones. The manufacturers of these goods design the product, organize the suppliers to make the thousands of tightly interdependent parts, and have them assembled and tested, either overseas or at home. The flow of goods from suppliers is matched with a corresponding flow of data from the lead manufacturer.

The same applies to semiconductors. According to the Biden administration's hundred-day supply chain review, released June 2021, the typical semiconductor production process includes multiple countries and may require the semiconductor to cross international borders up to seventy times before reaching its final destination. Such a complicated supply chain requires intense coordination and planning.

For regulated products like pharmaceuticals, the factories that produce the drugs or the "active pharmaceutical ingredients" must be approved by regulators. As the Biden supply chain review notes, "a single drug product often has multiple ingredients, including many inactive ingredients, and may have a critical container or closure type to ensure continued quality (e.g., a glass vial)." All of the ingredients have to be coordinated and quality-approved.

In other words, international trade in the twenty-first century is not simply about flows of goods across borders. Rather, the flows of data to organize production and trade are equally essential. So when you hear the term "supply chain," you should think about a "supply-and-data chain" instead. It's the cross-border flows of data that distinguish supply chains from the classic mode of arms-length international trade.

In that spirit, supply-chain management has been defined by the Association of Supply Chain Management as the "design, planning, execution, control, and monitoring of supply-chain activities with the objective of creating net value, building a competitive infrastructure, leveraging worldwide logistics, synchronizing supply with demand and measuring performance globally." Note that

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this definition leans heavily on the data component of the supply chain.

It would not be possible to build a heavily integrated product like a car or smartphone economically without the coordinating function of a global supply-and-data chain. This enables companies to take advantage of global

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economies of scale and specialization for some steps in the production process while utilizing low-cost labor for other steps. Today's digital economy would not be the same without global supply chains.

However, global supply chains are potentially more fragile than they seem. How fragile? We don't know, because global supply chains are not tracked by the conventional economic statistics. U.S. trade statistics measure flows of goods across national borders, but they do not track the flows of data that are an essential component of supply-and-data chains. Nor do trade statistics track the network of trade and production interconnections necessary to make today's complex products.

As a result, we are missing even the most basic data. We have no way of knowing how much of U.S. foreign trade is organized in supply-and-data chains and how much is classic "arms-length" markets. It is notable that the Biden administration's signature supply chain review did not once cite the Bureau of Economic Analysis, the agency charged with calculating GDP growth. The Bureau of Labor Statistics, in charge of productivity, employment, and price statistics, was cited once in passing. That shows the paucity of official statistics on supply chains. The United States has statistics on total imports, but no figures showing how imported goods and services are used in various industries, or where they came from originally.

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Consider pharmaceutical products, for example. We know that imports of pharmaceutical products totaled \$163 billion in 2020. However, according to the Biden supply chain report, there is little transparency into the origins of the “active pharmaceutical ingredients” within generic drugs, which represent 90 percent of all pharmaceuticals consumed in the United States. The Food and Drug Administration approves production facilities, but does not track how much is produced at each factory. So we have no clue how much of our pharma products are ultimately sourced from China. Nor do we know if there are alternative sources with sufficient capacity to make up the difference if one or more links in the pharmaceutical supply chains were cut off.

The same lack of knowledge holds for all other supply chains as well. The U.S. government has been trying to get insight into the semiconductor supply chain by asking semiconductor manufacturers and suppliers about their inventories, production, and key customers for specific products. But according to an October 2021 article in *Nikkei Asia*, non-U.S. companies such as TSMC, the Taiwan-based semiconductor leader, were balking at providing such sensitive and detailed data to the U.S. government.

It should be noted that requests for specific customers is highly unusual for economic surveys. The Economic Census done every five years in the United States asks companies for information on their U.S. costs and production by product, but without any detail about individual buyers or suppliers. Nor does the Economic Census ask companies to quantify their supply chains or about potential bottlenecks.

But that kind of detailed data is exactly what is needed to assess supply chain resilience, or identify potential points of supply chain failure. There may be five manufacturers of similar products in the United States, but if they all rely on the same sole supplier of a crucial input in Japan or Taiwan, then that’s a potential bottleneck.

It’s also important to understand that supply chain failures can arise from a variety of different causes. Sudden disastrous events like a fire or earthquake can put a crucial plant out of action for some time. Transportation links can become snarled.

But supply chain failure can also come from an unexpected shift in demand as well. For example, the automobile industry is suffering from a shortage of semiconductor chips, in part due to cutbacks in orders by car makers at the beginning of the pandemic. As a result, semiconductor suppliers shifted production away from automotive chips to consumer electronics.

But we have so little information about global supply chains that we can’t rule out hidden causes as well. For example, the location of supply chain activities is often

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responsive to tax considerations. The OECD project for applying a new tax framework to digital companies will also affect the taxation of global supply chains, where so much of the value is created by the use of data. It is possible that the OECD’s “two pillar solution” is causing companies to rethink where they locate production.

The big picture: Going forward, we need a new approach to assess supply chain resiliency.

Resiliency is a systems or network property, which cannot be immediately derived from existing economic statistics. As the Biden supply chain review noted, “the search for low-cost production, combined with the effective industrial policy of key nations, has led to geographic concentrations of key supply chains in a few nations, increasing vulnerabilities for United States and global producers.”

This poses some interesting questions about how to collect the necessary information about supply chain behavior and vulnerabilities without forcing multinational companies to routinely specify their global customers and suppliers for different products and inputs, an intrusive level of detail that economic statisticians have never asked for in the past. Finding the right balance between protection of sensitive business data and the needs of a resilient economy is going to be an important issue going forward. ◆