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Bloomberg Terminal

# Global Supply Chains

## Report for the New Economy Forum

November 2021

**Bloomberg Economics**



**Bloomberg  
Intelligence**



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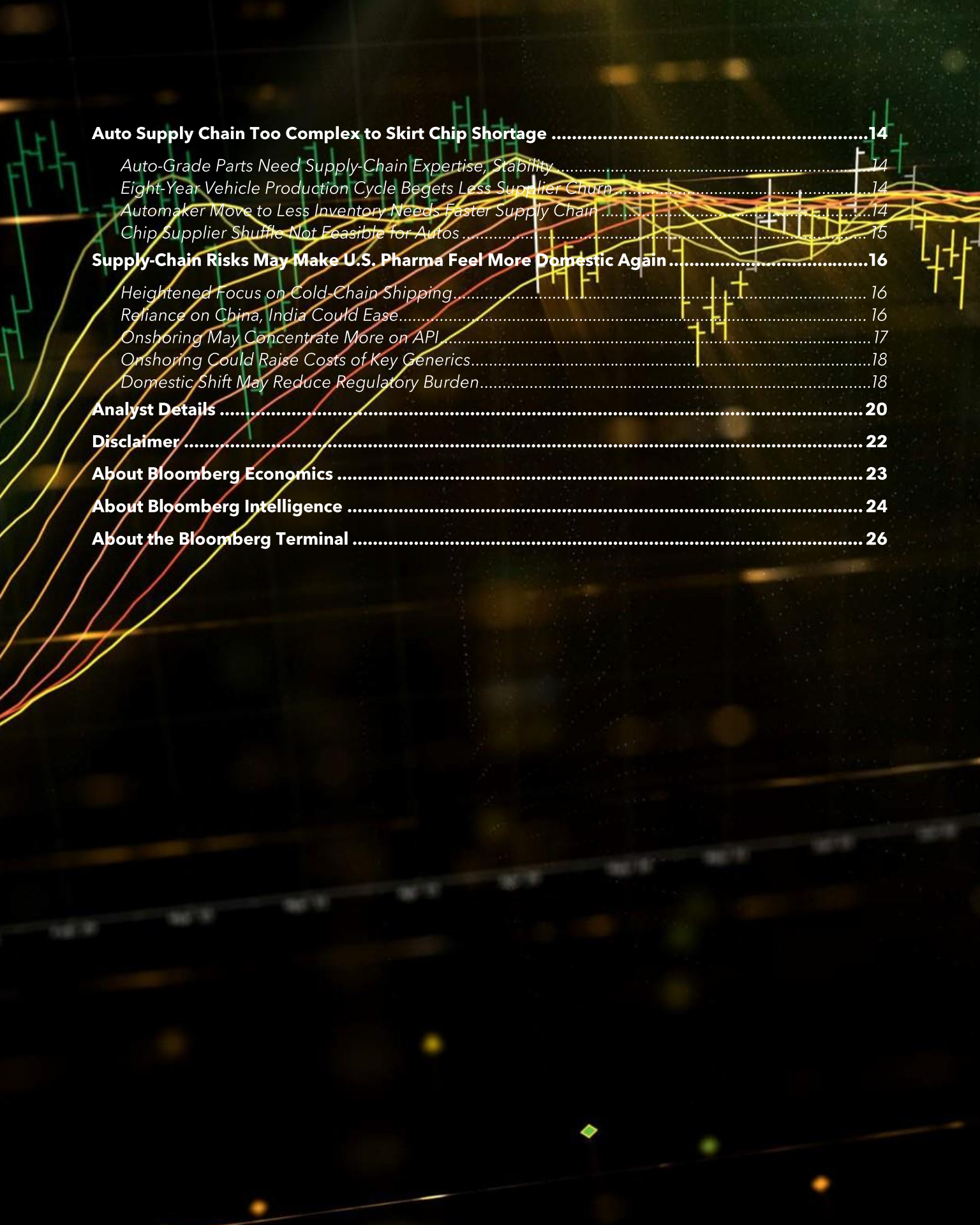
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# Foreword

The Covid-19 crisis has stretched supply chains to breaking point. Coming hard on the heels of the U.S.-China trade war, and amid the looming threat of climate change and advances in technology that are shifting business models across industries and services, the debate about the future of global trade is getting all the more critical.

In this report for the New Economy Forum, Bloomberg Economics and Bloomberg Intelligence join forces to forecast the outlook for global supply chains, and model risks from fraying U.S.-China relations and carbon taxes. Moving to the micro from the macro, we dig into what the future holds for supply chains in three key sectors: tech hardware, autos and pharmaceuticals.

We think this work showcases some of the best of Bloomberg research, and hope it helps inform the global debate and the discussions between global leaders and opinion shapers at the New Economy Forum. For more detail on the economics and industry aspects of supply-chain evolution, check out BI<GO> and BECO<GO> on the Bloomberg Terminal.



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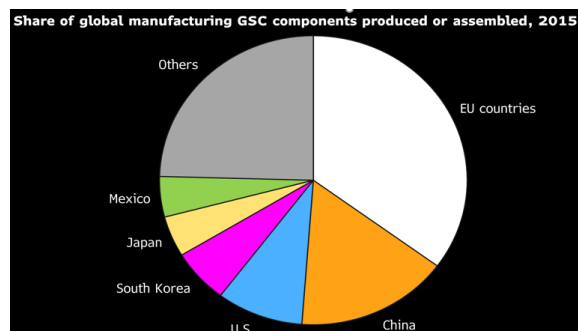
# Supplies Chained - How Hot Climate, Cold War Could Reshape Trade

Global supply chains are buckling from pandemic shocks. The fight against climate change and a deepening rift between the U.S. and China means there may be more disruption to come. Using detailed data on trade flows and a large-scale model of the global economy, Bloomberg Economics has mapped existing supply chains, identified the drivers of participation, and put numbers on the impact of climate change and trade-war scenarios.

## Who Dominates Global Supply Chains? China, Germany, U.S.

We use the OECD's Trade in Value Added database to track manufacturing value added from spoke countries (which produce intermediate inputs) to hubs (which assemble them into products for final consumption). The first conclusion that jumps out from the data - size matters. China, Germany and the U.S. account for the lion's share of value added in cross-border supply chains.

## Global Supply-Chain Participation

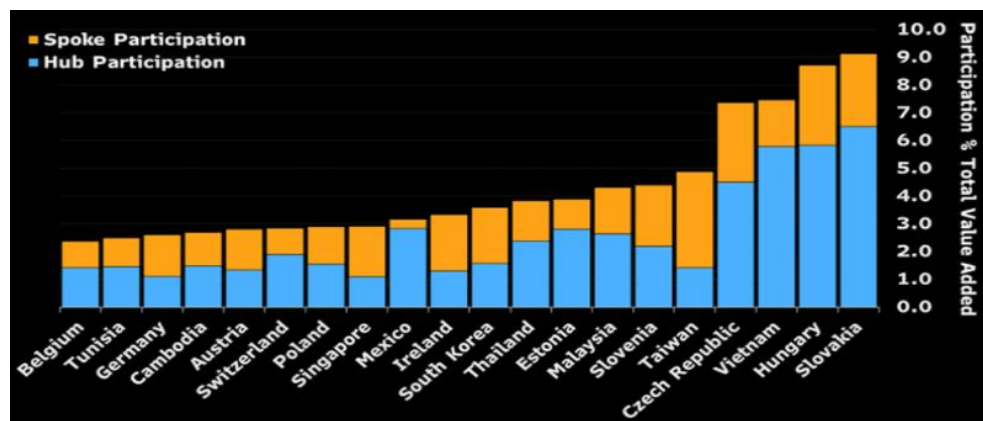


Source: OECD TiVA (2015), Bloomberg Economics

## Eastern Europe, Asia Punch Above Weight in Global Supply Chains

Many smaller economies punch above their weight in trade. Slovakia, Hungary and the Czech Republic stand out in central Europe, with participation in global supply chains equal to 7-9% of their GDP. Vietnam leads in Asia, with Taiwan and Malaysia not far behind. In the Americas, it's Mexico that is most deeply enmeshed, serving as a critical hub for assembly of products for U.S. consumption.

## Global Supply Chain Participation



Source: OECD TiVA (2015), Bloomberg Economics

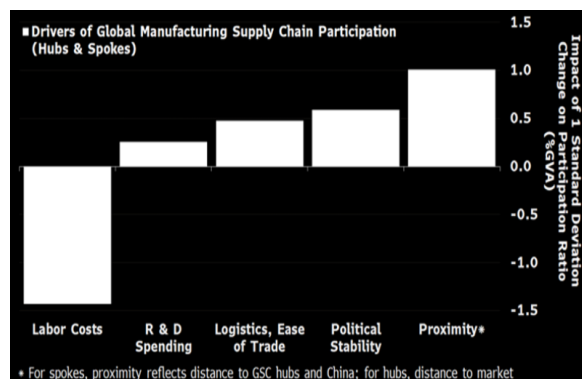


## Low Costs, Big Markets Pull Countries Deeper Into Supply Chains

Why do some economies play a bigger role in global supply chains than others? Using a panel regression on data from more than 60 economies, we identified the main factors. Labor costs matter most, with lower-cost economies more active in supply chains. Geography is also important. Spokes benefit from being close to a major manufacturing hub, while those hubs are at an advantage if they can get their assembled products quickly to a big final market.

Controlling for costs and proximity, institutional quality and the business climate have some explanatory power. Political stability, quality of trade logistics and infrastructure, and the level of research-and-development spending all help to determine a country's integration into supply chains.

### Drivers of Supply-Chain Participation



Source: Bloomberg Economics

## Asia's Growth to Open Opportunities for Regional Trade

Most factors driving participation in global supply chains are sensitive to economic development. As China continues to grow, for example, Asian neighbors will benefit from proximity to a bigger market for their goods. And as those neighbors get richer, we expect they'll become more stable and see improvement in areas like logistics quality.

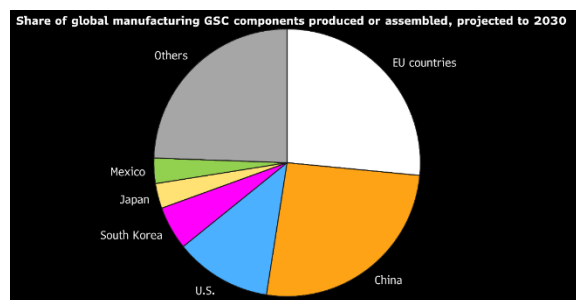
Drawing on Bloomberg Economics' GDP forecasts, our projections suggest Asia will see the biggest increase in cross-border trade. South Korea, Vietnam and Cambodia look likely to see the biggest gains through

2030. Europe could lose ground because of its distance from faster-growing markets.

## Supply Chains Slow to Evolve, But China's Role Could Get Bigger

While there will be winners and losers, one of the main takeaways from our projections is that, absent major shocks, supply chains won't look dramatically different in 2030 than today. As the chart shows, China, Germany and the U.S. are likely to retain their dominant role. Within that group, it is China that has the most potential to grab an even larger share of global trade.

### Global Supply-Chain Participation in 2030



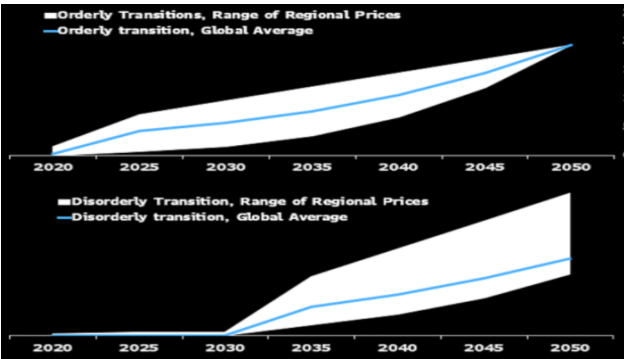
Source: OECD TiVA (2015), Bloomberg Economics

## Costing Out Climate Transition -- Scenario for Carbon Prices

To understand how climate change might reshape global trade, we use two scenarios for carbon prices from the Network for Greening the Financial System, both consistent with limiting global warming to below 2 degrees Celsius. Immediate, coordinated action across countries would push up carbon prices globally to about \$200 per tonne by 2050. If action is delayed until 2030, the required increase would be steeper -- to \$600 per tonne in 2050.

Under the latter scenario, the NGFS assumes high variation in carbon prices and emission reductions between countries. This might open a third path, with the U.S., Europe and Japan introducing a border tax on imports to effectively impose their higher domestic prices for carbon on trade partners.

### Scenarios for Carbon Prices



Source: NGFS, Bloomberg Economics

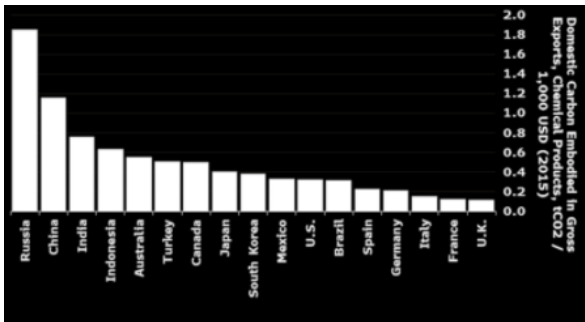
### Carbon Pricing Impacts Comparative Advantage, Trade Flows

The introduction of carbon prices affects relative prices, and so changes the pattern of comparative advantage that determines global-trade flows. Countries with lower initial carbon intensity, able to reduce emissions at a lower cost, or facing slower increases in domestic carbon prices should gain market share at the expense

of competitors that are less well placed to make the transition.

With lower emission intensity and ambitious emission-reduction plans, western European countries stand to do well. Russia, with its fossil-intensive production and exports of carbon-intensive goods to greener Europe, faces a much more challenging adjustment process.

### Carbon Intensity of Production



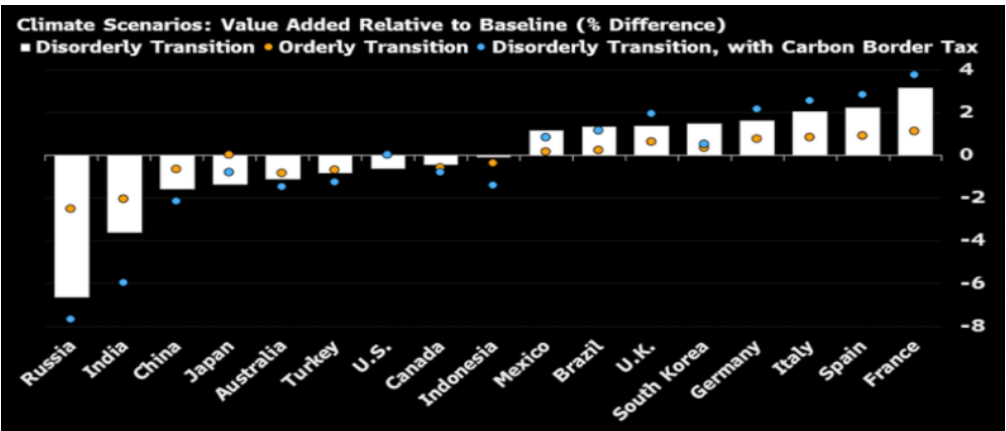
Source: NGFS, OECD, Bloomberg Economics

### Climate Transition Could Reshuffle Global Trade -- BE Scenarios

Armed with estimates of changes to relative production prices under our three scenarios, it's possible to estimate the impact on trade and GDP. In an orderly transition, the overall effect would be small, but countries with higher initial emission intensity of production, such as Russia and India, would tend to lose out, while Europe should gain. These effects would be magnified in a disorderly transition, and even more so if the U.S., Europe and Japan attempted to protect domestic producers with a carbon border tax.

As the chart shows, in that scenario, Russia loses about 8% of GDP and India 6%. France sees gains of close to 4% of GDP and its European neighbors also gain as more production moves to their relatively carbon-efficient economies.

### Winners, Losers in Climate Scenarios



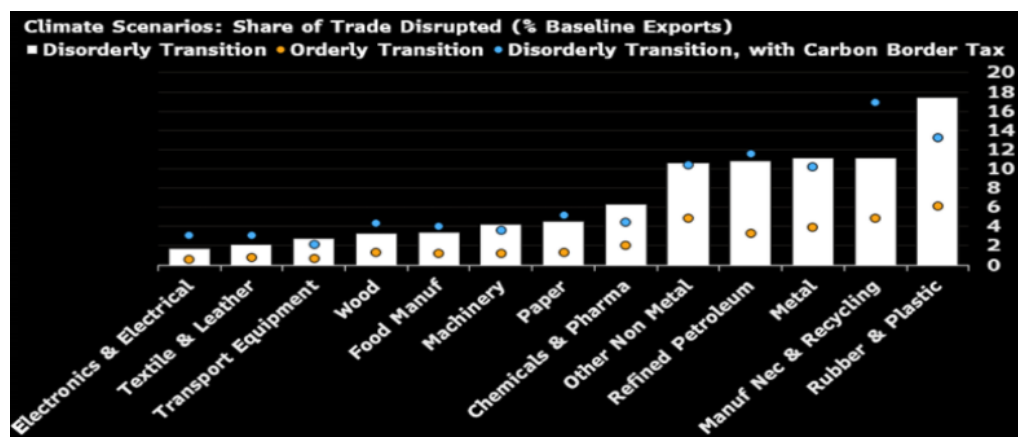
Source: Bloomberg Economics



## High Carbon Intensity Sectors to Face Deeper Adjustments

Carbon prices are expected to have a larger effect on relative prices for sectors with higher emission intensity. As a result, trade of rubber and plastic, metal products and cement is expected to be more deeply impacted in a carbon transition. Waste recycling services could also be very impacted, with a significant effect on the Indian economy.

### Trade Disruption in High Emission Intensity Industries



Source: Bloomberg Economics

## Three Scenarios for U.S.-China Decoupling to Upend Global Trade

With the end of the Trump administration, much of the heat has come out of U.S.-China relations. The chill that has replaced it is far from reassuring. Diplomatic ties remain strained, tariffs and technology sanctions remain in place, and the U.S. is increasingly attempting to work with allies on a coordinated strategy to respond to China's rise. A plausible base case is that tensions continue to simmer, with no catalyst for a further deterioration.

Still, the lesson of the past few years is that things can change fast. We've explored three scenarios: a further deterioration in U.S.-China trade, a complete breakdown in bilateral ties and a new cold war, forcing countries to pick a side depending on where their existing trade ties are strongest.

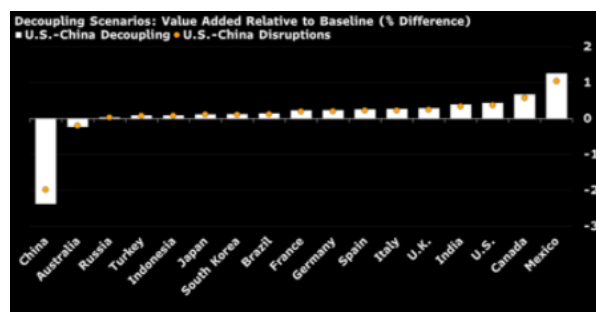
## U.S.-China Decoupling Bad News for China, Good News for Mexico

In our first scenario, we consider a further deterioration in U.S.-China ties -- equivalent to the two countries imposing a 50% tariff on all bilateral trade. If that happens, China loses about 2% of GDP as exports fall. The U.S. gains about 0.4% of GDP as production

returns home. Mexico and Canada do even better, with Mexico gaining about 1% of GDP as low-cost production shifts out of China and looks for a new base close to the U.S. market.

We also consider a complete breakdown in bilateral ties -- effectively turning off all U.S.-China trade. In that second scenario, the pattern of winners and losers is the same, but the impacts are larger. China's losses go up to 2.4% of GDP. Gains for the U.S., Canada and Mexico edge higher.

### Two Views of Decoupling



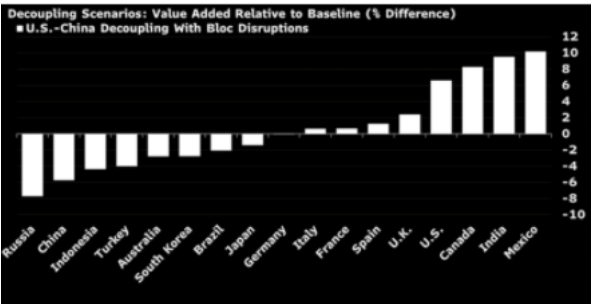
Source: Bloomberg Economics

**New Cold War Would Have Extreme Impacts on China, U.S. Blocs**

We also consider what would happen if a complete breakdown in the U.S.-China relationship forces every other country to pick a side. We model this by assigning countries to separate blocs, depending on where their existing trade ties are strongest, then turning off U.S.-China trade entirely and imposing a 100% tariff between blocs. Unsurprisingly, the effects of such a scenario are extreme.

Overall, 40% of existing trade flows would be destroyed. China says goodbye to about 6% of GDP, and countries in China’s bloc -- Asian neighbors and big commodity exporters like Russia and Brazil -- also lose out. The U.S. gains about 7% of GDP. Canada, Mexico and India do even better.

**Complete Breakdown Between Blocs**



Source: Bloomberg Economics

**Bloc Decoupling Would Trigger Broad-Based Disruptions**

In a U.S.-China decoupling scenario, the electronics and textile industries could suffer important disruptions -- as the exports of those products from China to the U.S. would be either replaced by domestic production in the U.S. or displaced to other trade partners like Mexico.

A split between a U.S. bloc and a China bloc would have a much deeper impact on global trade relationships. Forty percent of all global trade flows would be either destroyed or displaced, and the effect would be broad based across all industries.

**Sector Impact of U.S. - China Decoupling**



Source: Bloomberg Economics

# Chip Shortage May Take Time to Overcome

Chip shortages appear set to persist, having developed over several years. Automotive chip scarcity may ease in 3Q22, in our scenario, and may be resolved as late as 2Q-3Q in 2023 in our slow-recovery scenario. Taiwan Semiconductor Manufacturing Co. (TSMC) could help drive higher chip production for Apple, Nvidia, Qualcomm, Renesas Electronics and NXP Semiconductors.

## Supply-Demand Imbalance May Persist

Semiconductor manufacturing capacity shortages have developed over a period of years, and a fix has yet to emerge. Despite expansion plans at Intel, Taiwan Semiconductor and other integrated device manufacturers (IDMs) and foundry chipmakers, demand still may absorb capacity growth over the next two years. Capacity -- measured by 8-inch wafer equivalents -- should rise 7%, according to data provider SEMI. Demand may continue to be strong due to 5G smartphones, artificial intelligence, robotics automation and driverless cars. Semiconductor sales are set to gain 8% in the next two years, outpacing capacity growth.

Post-pandemic views of risk management may structurally change inventory patterns if companies switch from just-in-time manufacturing models to something more like "just-in-case."

## End-Market Sales, Capacity Expansion



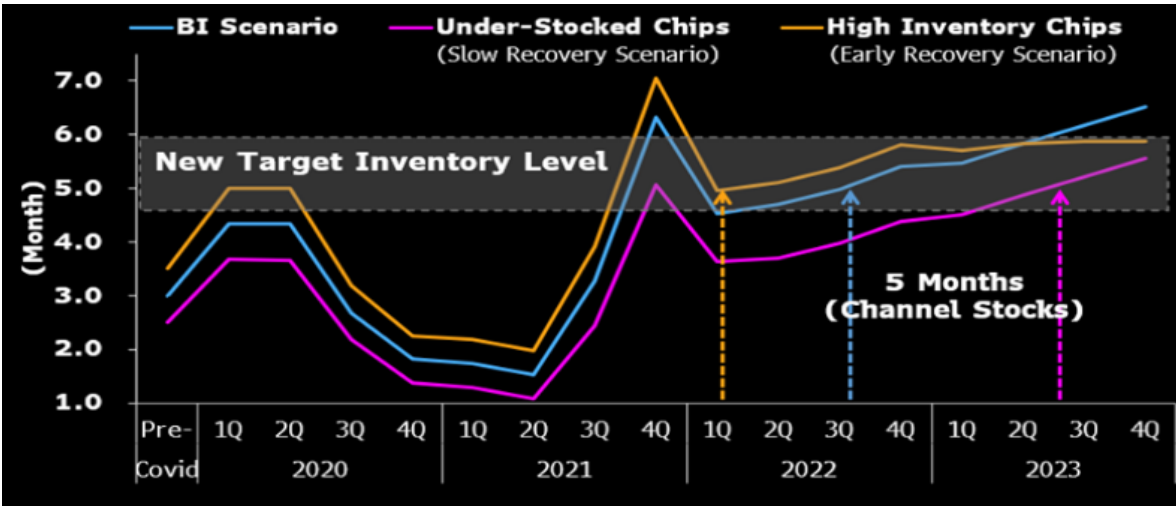
Source: IDC, SEMI

## Chip Inventory May Be Ready to Normalize

Automotive-chip inventory across the supply chain may reach a sufficient level in 3Q22, based on our scenario analysis. Months of inventory -- the sum of chipmaker inventories and channel stocks, those held by automakers, tier-1 part makers and distributors -- could normalize at a new level of five to six months. Yet chipmakers may face inventory shortfalls even in 2022, while production could stay strong until 2023.

For understocked chips or the slow-recovery scenario, supply-chain inventories may rise to five to six months in 2Q-3Q of 2023, a delay of one year vs. our scenario. If chipmakers held larger inventory before the pandemic or the early recovery scenario, automotive supply-chain inventories could reach an appropriate level in 1Q22.

# Auto-Channel Stock Scenario Analysis

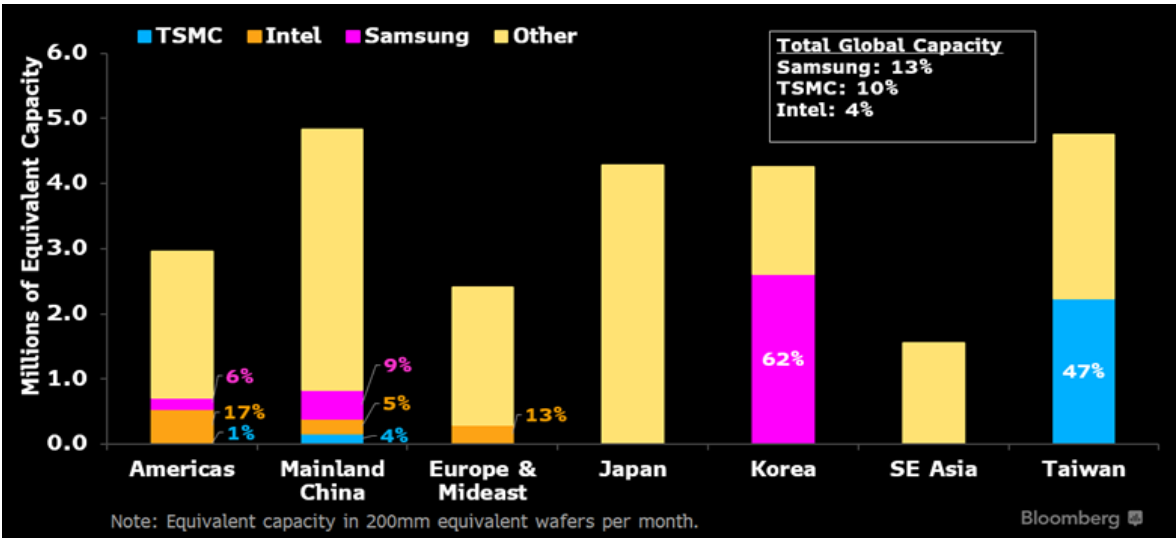


Source: Bloomberg Intelligence

## Chipmaking Capacity Faces Regional Bottlenecks

Amid global shortages, semiconductor chipmaking capacity could remain regionally skewed, creating supply chokepoints across product types. Most regional capacity may continue to be dominated by a cadre of behemoths -- Intel in MPUs in the U.S., Samsung in South Korea in memory and TSMC in Taiwan in outsourced chipmaking or foundry. Foundry, or outsourced, manufacturing across chip categories is a key chokepoint, particularly given the sector's high exposure to various logic chipmaking for Apple, Nvidia, Qualcomm, Advanced Micro Devices, Renesas Electronics and NXP Semiconductors.

### Regional Wafer Capacity With Top Players (1Q21)



Source: SEMI



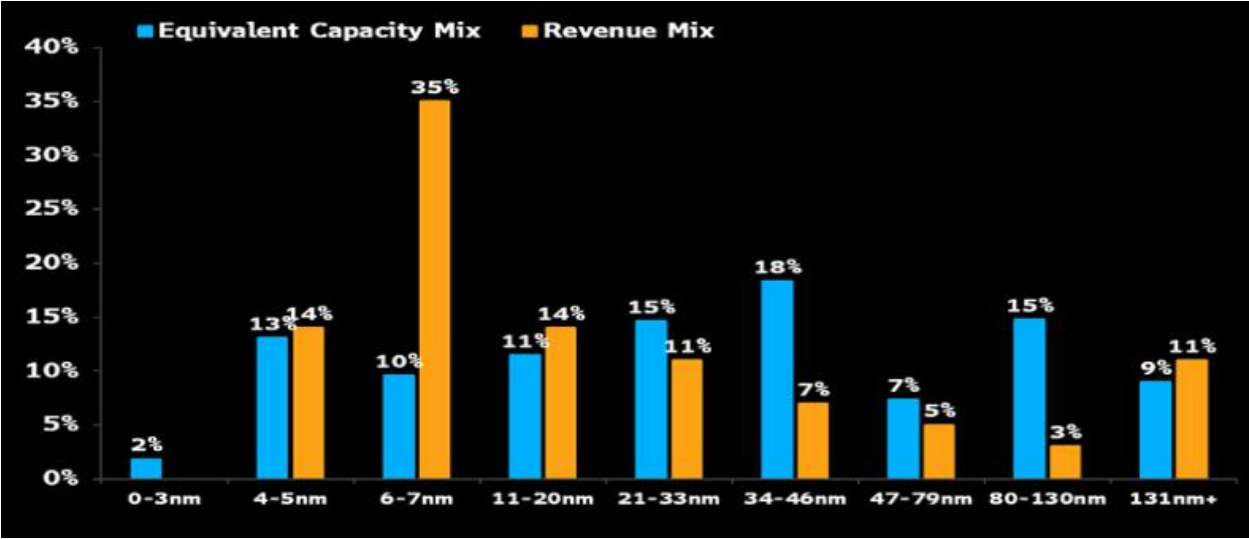
Intel's factory expansions for its two Arizona facilities and in New Mexico may offer little relief to the near-term supply crunch. Intel's success with capacity expansion could also be highly contingent on its transistor-pitch shrinkage.

**Transistor-Shrinkage Roadmap Critical**

TSMC, Samsung and probably Intel may remain the only chipmakers at the advanced nodes -- such as 7-nanometer or below -- used for Apple's processors, Nvidia's graphic chips and Qualcomm's 5G chips, for the next few years. A successful migration roadmap, especially for TSMC, is critical because it paves the way for other less-complex chips technologically and economically.

Chinese companies may not seriously contend for advanced chipmaking leadership over the next few years in memory or foundry. The group's largest expansions, mostly in memory, have been subscale when compared with Samsung's, and its foundry capacity, mostly through SMIC, has been weaker than behemoth TSMC.

**TSMC Wafer Capacity vs. Revenue Mix by Node (1Q21)**



Source: SEMI, Company Filings

# Auto Supply Chain Too Complex to Skirt Chip Shortage

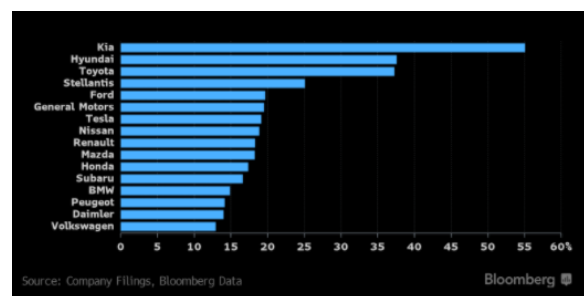
Automakers have few options to prevent supply disruptions such as the global chip shortage that has dwindled new-vehicle supply -- most seriously in the U.S. -- though Volkswagen may have more flexibility and Tesla and Toyota the least. The complexity, collaboration and cost involved in changing out any of the thousands of top-tier suppliers raises risk, while the high-quality grade of parts for autos rules out easy alternatives.

## Auto-Grade Parts Need Supply-Chain Expertise, Stability

The global semiconductor shortage that may reduce new-vehicle assemblies by 8 million units worldwide in 2021 -- and North America retail revenue by \$100 billion -- can't be skirted by swapping suppliers in the middle of a production cycle. Supply-chain relationships and chip design, requirements and integration with other systems have been developed over years and involve guaranteed contracts. Domestic manufacturers would need years and prohibitive expense to flip to new suppliers that would introduce many unknowns, including quality and durability needs far greater than what's acceptable in other consumer-electronics applications.

Ford has \$4.2 billion in total purchase obligations and 1,400 tier 1 suppliers, while General Motors counted purchase orders with more than 5,000 direct and indirect parts providers in 2020.

## % of COGS Automakers Pay Top 10 Suppliers



Source: Bloomberg Intelligence

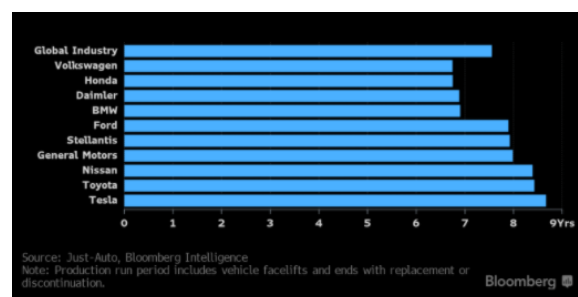
## Eight-Year Vehicle Production Cycle Begets Less Supplier Churn

The global auto industry's tendency to maintain eight-year production runs for vehicles -- broken up by a midcycle refresh or facelift -- is an indicator of the

obduracy of parts contracts between manufacturer and supplier. Pandemic-idled production and the worldwide chip shortage has hamstrung the recovery, though only expiring contracts and vehicle plans not yet in production are the real opportunities for automakers to regionalize their supplier base. Of the largest global automakers, Volkswagen averages the shortest production runs, while Tesla -- though lacking global scale -- and Toyota maintain the longest, above eight years each.

Europe-based automakers average 6.7 years per production run, shorter than either U.S. or Asian manufacturers -- which are above 7.4 years.

## Average Production Run Duration by Automaker



Source: Bloomberg Intelligence, Just Auto

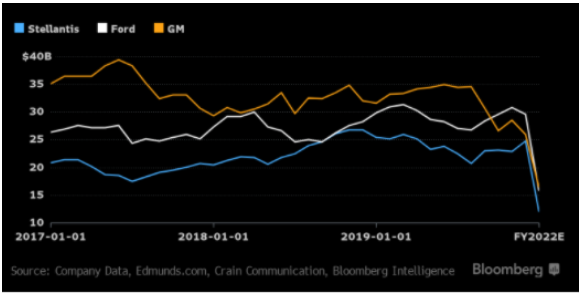
## Automaker Move to Less Inventory Needs Faster Supply Chain

Structural changes in the supply and demand balance across the global auto industry that's driving prices higher and margins wider will manifest as a reduction in capital-sapping stockpiled parts and vehicle inventory. Ford's goal of reaching double-digit pretax margins is based on trimming supply to 50 days in the U.S. -- from an average of 77 in 2014-19 -- slashing supply by 337,000 units and freeing up \$15 billion from slower-selling models. More constrained output of vehicles at General Motors and Stellantis -- from more

than 80 days pre-pandemic -- will firm pricing and shift leverage away from consumers to manufacturers and dealers.

The lack of U.S. supply has reduced discounts from MSRP by \$2,500 per vehicle in favor of dealerships in 2021, while manufacturers are spending \$1,700 less in factory incentives.

**Inventory Value in U.S.**



Source: Bloomberg Intelligence, Edmunds.com, Crain Communication

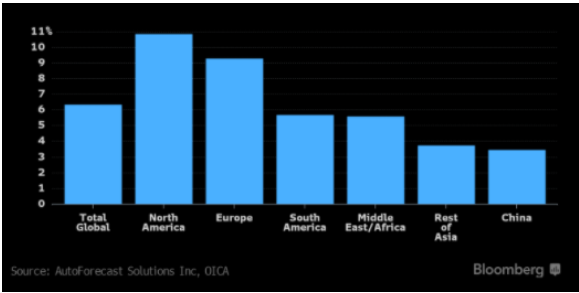
**Chip Supplier Shuffle Not Feasible for Autos**

North America-based automakers face the highest potential production losses of any region due to the chip shortage, as they are overly dependent on the domestic market. U.S. semiconductor producers generate \$12 billion in revenue from the auto industry,

37% more than European peers and only 12% less than Asia chipmakers. Ford, GM and Tesla generate a relatively small revenue pool, 72% less than Asia-based rivals and 52% below European peers. This shows that U.S. automakers will remain committed to domestic suppliers, as they lack the revenue scale to secure contracts with foreign chipmakers.

Texas Instruments, ON Semiconductor, Micron and Microchip Technology all generate more than \$1 billion from the auto industry; none get more than 34% of revenue from vehicle manufacturing.

**Projected Lost Production Compared With 2019**



Source: AutoForecast Solutions, OICA

# Supply-Chain Risks May Make U.S. Pharma Feel More Domestic Again

U.S. pharma companies weighing the costs of pandemic supply-chain disruptions may shift to more domestic production of critical ingredients after years of rising imports from China and India. Their decisions could be swayed by congressional pressure, the FDA focus on foreign inspections and growing use of biologic and gene therapies with stringent temperature requirements.

## Heightened Focus on Cold-Chain Shipping

As complex biologics and gene therapies become more prevalent, we believe cold-chain shipping may become a bigger factor in the pharmaceutical supply chain and accelerate U.S. companies' shifts to more localized manufacturing. Total biologics and gene therapies have grown at a compound annual rate of 13% over the past 10 years, according to Symphony Health data, and typically must be maintained at very low temperatures during shipping until they are thawed immediately before use.

In the supply chain, raw materials are developed into the critical active pharmaceutical ingredients (APIs), which are added with excipients, or non-active ingredients, and then measured for dosing and packaged to create finished drugs.

## Pharmaceutical Manufacturing Chain Hinges on API



Source: Bloomberg Intelligence

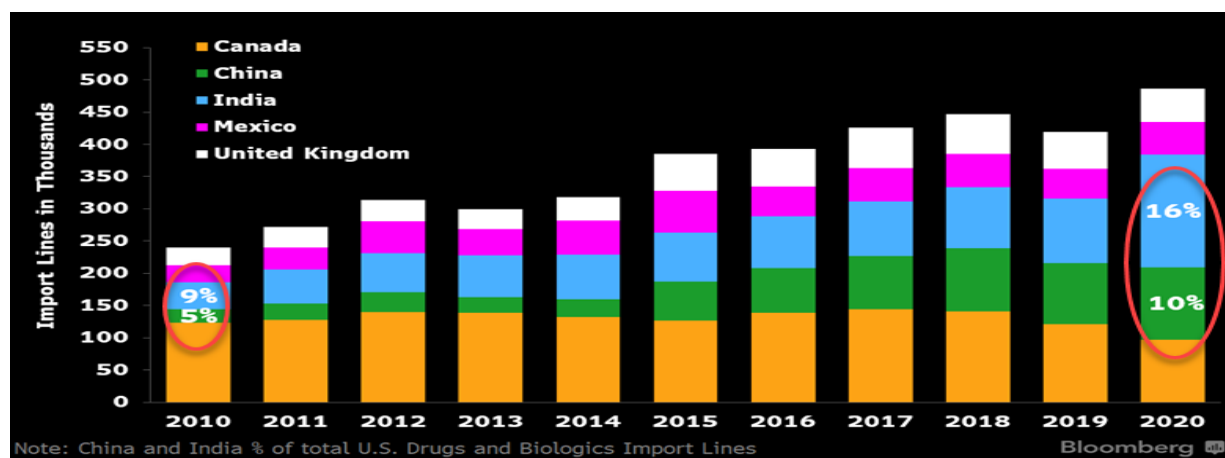
## Reliance on China, India Could Ease

The share of U.S. pharmaceutical imports from China and India has risen significantly in the past decade but could see some reversion as pandemic-related supply-chain disruptions attract government scrutiny and raise questions about the costs of foreign manufacturing. The two countries combined comprised less than 15% of all U.S. pharmaceutical import lines in 2010 -- which had almost doubled by 2020, based on FDA data. Some of that growth could abate under President Joe Biden's American Jobs Plan, which calls for more than \$52 billion in investments in domestic manufacturers as well as \$30 billion to prepare for future pandemics and onshore API manufacturing

Canada, Mexico and the U.K. account for other major pharmaceutical import lines, representing 9%, 5% and 5%, respectively, of total U.S. import lines in 2020.



## Pharmaceutical Manufacturing Chain Hinges on API



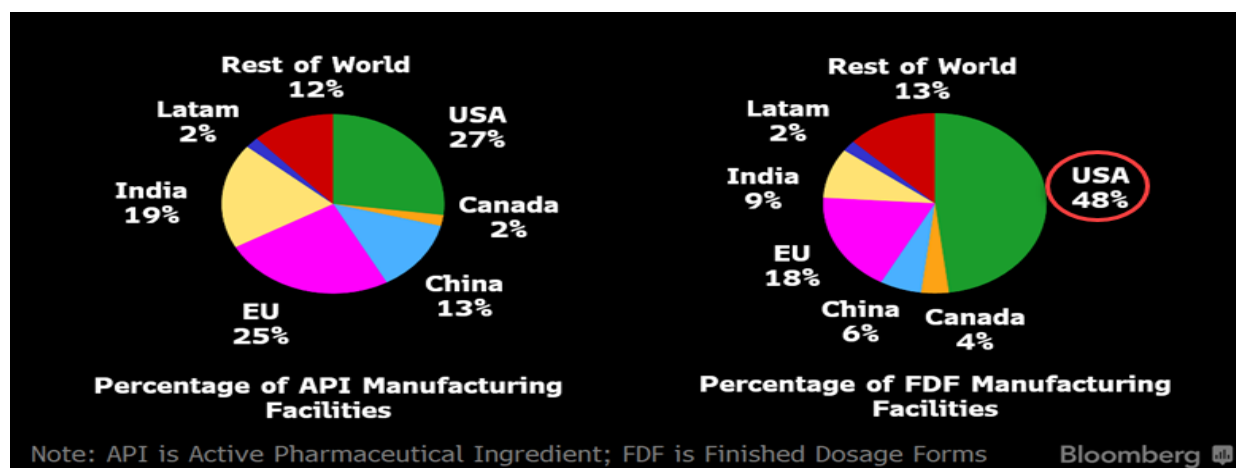
Source: FDA; Bloomberg Intelligence

## Onshoring May Concentrate More on API

Nearly half of finished dosage forms (FDFs) are already produced in the U.S., so we expect onshoring efforts may focus more on active pharmaceutical ingredient (API) facilities. FDA data show China and India make up only 15% of FDF plants, compared with over 30% of API facilities. By contrast, the U.S. represents 48% of FDF plants and only 27% of API facilities.

The API market is produced about 60% in-house globally, with the remaining 40% purchased on the merchant market from third-party suppliers, according to Clarivate Analytics. It's common for large pharmaceutical manufacturers to purchase at least a portion of their APIs on the merchant market, even if they produce much of their API in-house. We estimate about three-quarters of U.S. APIs purchased on the merchant market are for branded drugs.

## China, India Accounted for 15% of Finished Dosage Forms in 2020



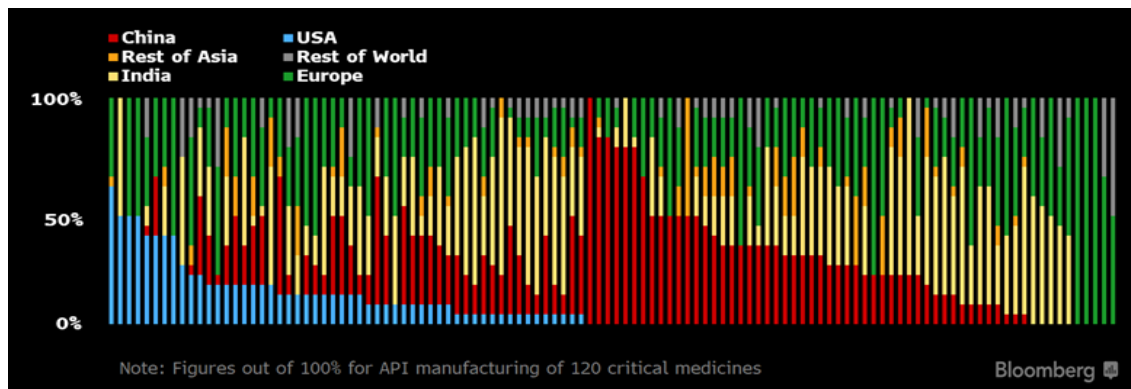
Source: FDA; Bloomberg Intelligence

## Onshoring Could Raise Costs of Key Generics

Despite the U.S. government's focus on domestic manufacturing, it could take years for the industry to ramp up and at hefty costs, as nearly half of key drugs on the FDA's List of Essential Medicines lack U.S. API manufacturing sites. Published in October, the list includes well-known medications like aspirin, penicillin, ibuprofen, morphine and epinephrine -- all considered critical for acute care and medical countermeasures during public health emergencies.

Upgrading manufacturing facilities could take about a year. Building new ones may take up to five years, require significant upfront investment and lead to higher annual operating costs. Such operating costs in India could be under \$15 million per facility, but at least \$40 million in the U.S., according to pharmaceutical manufacturing consultant Boyd.

### China, India Have Majority of Key Medication API (Jan-June 2021)

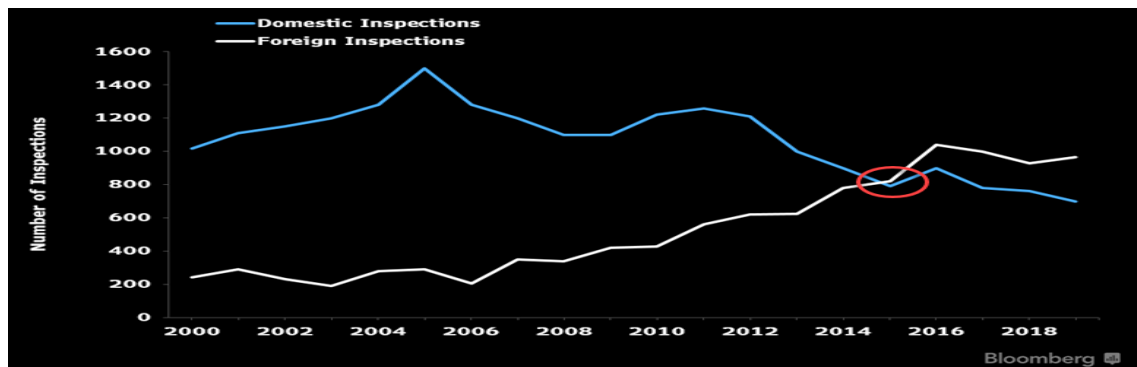


Source: White House Report; Bloomberg Intelligence

## Domestic Shift May Reduce Regulatory Burden

Increased onshoring could ease the burden of the FDA's international inspections, which have become a weight on cost and staffing capacity. As foreign-based API manufacturing has expanded, so has the number of more expensive international inspections. Foreign-facility inspections surpassed domestic ones for the first time in 2015, and they represented almost 60% of the FDA's total in 2019. In 2005, the FDA implemented a risk-based approach to inspections of facilities, targeting those that would have the greatest potential for public health risk should they fail to comply with quality standards. The agency measures that potential based on the facility type, patient exposure, inspection history and hazard signals, among other criteria.

### Foreign Inspections Outnumbered Domestic in 2015



Source: FDA; Bloomberg Intelligence



34.57

97.04

72.81

36.84

64.16

28.78

8.43

2.57

19.84

30.91

12.73

20.37

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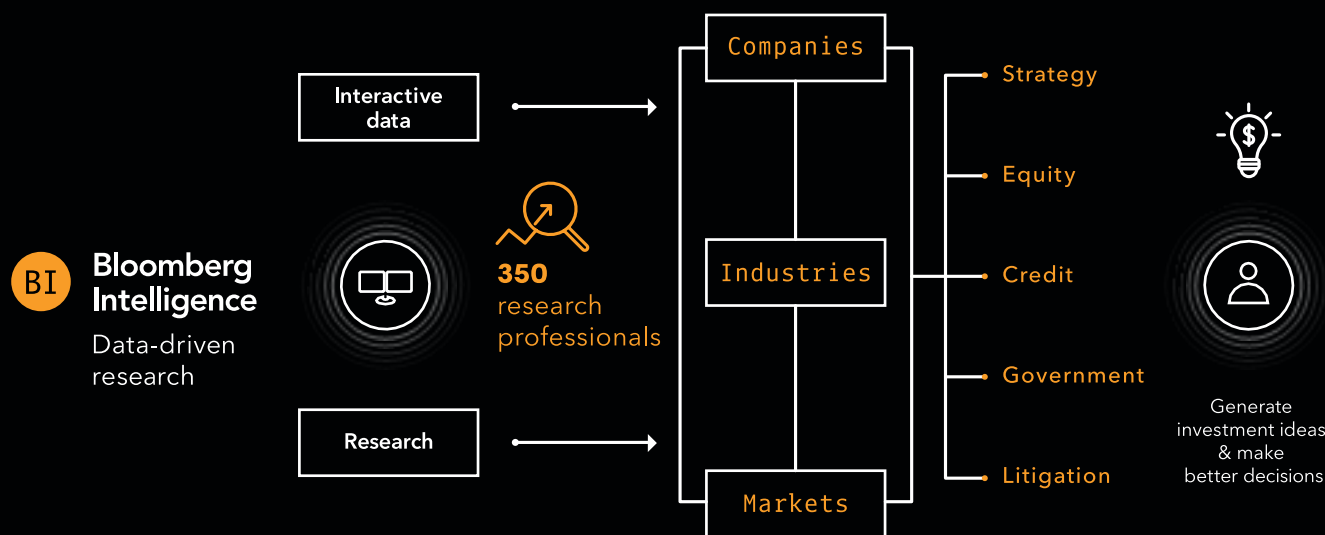
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