

The Roadblocks of the COVID-19 Pandemic in the U.S. Automotive Industry

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Abstract

The automotive industry is one of the largest manufacturing sectors in the United States. However, the onset of the COVID-19 pandemic brought with it two major shocks to the U.S. automotive industry, which led to major declines in production, sales, and international trade for 2020 and 2021. The first of these shocks—nationwide factory shutdowns—brought production to a short but drastic halt in early 2020 (with over 90 percent of domestic automotive production temporarily shutting down), while the second—shortage of automotive semiconductor chips—created a less drastic, but more prolonged drag on production that continued into 2021 and beyond. This paper explores each of these disruptions independently, examines the impact of both, and concludes with a discussion of the outlook of the automotive industry in 2022 and beyond.

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Introduction

The COVID-19 pandemic has disrupted virtually every country and industry across the globe. The automotive industry in particular was highly vulnerable and negatively impacted, with U.S. vehicle sales declining 15 percent from 2019 to 2020.¹ This sales decline was almost twice the decline during the 2008-09 global financial crisis, when sales declined by 8.1 percent.² The automotive industry³ faced two major disruptions related to the COVID-19 pandemic; the first was the initial closure of automotive facilities in the first half of 2020 during the first outbreak in the United States, which throttled the available supply of automotive vehicles. The second is the ongoing shortage of semiconductor chips (“chip shortage” hereafter) throughout the automotive supply chain hindering the production needed to satisfy recovering consumer demand in the second half of 2020. This shortage also hindered vehicle sales, which in 2021 were still nearly 12 percent below 2019 sales.⁴ This paper explores each of these two disruptions independently, examines the impact of both, and concludes with a discussion of the outlook of the automotive industry in 2022 and beyond.⁵

The Closure of the U.S. Automotive Industry

Production Shutdowns: Mid-March through May 2020

U.S. light vehicle production (light vehicles include cars, crossovers, minivans, SUVs, and pickup trucks),⁶ sales, and trade declined significantly in the first five months of 2020, and disruptions to supply chains created further uncertainty. Vehicle producers shut down their U.S. plants in mid- to late-March and began restarting production in late April and early May (table 1). The Alliance for Automotive Innovation estimated that 93 percent of all automotive production in the United States had been temporarily shut down by late March, and total production in April was the lowest monthly production level since 1945.⁷

¹ Ward’s Intelligence, “[U.S. Total Vehicle Sales by Company](#),” March 1, 2021. Boucherat, “[The Automotive Industry Suffers most under COVID-19, say Materials Suppliers](#),” May 2020, 18-23.

² Kahl, “[COVID-19 Could Result in at Least 20 Million Lost Vehicle Sales](#),” May 2020, 4.

³ OICA, “[Production Statistics](#),” (accessed May 6, 2022), OICA, “Global Sales Statistics 2019-2021,” (accessed May 6, 2022); UN Comtrade Database (accessed May 6, 2022). Light vehicle HS subheadings are 8703.21, 8703.22, 8703.23, 8703.24, 8703.31, 8703.32, 8703.33, 8703.40, 8703.50, 8703.60, 8703.70, 8703.80, 8703.90, 8704.21, and 8704.31. The U.S. automotive industry is one of the largest in the world; U.S. light vehicle sales and production are the second highest in the world (behind China). The United States is also the largest importer and third-largest exporter of light vehicles.

⁴ Ward’s Intelligence, “[North America Sales By Vehicle Type](#),” February 10, 2022.

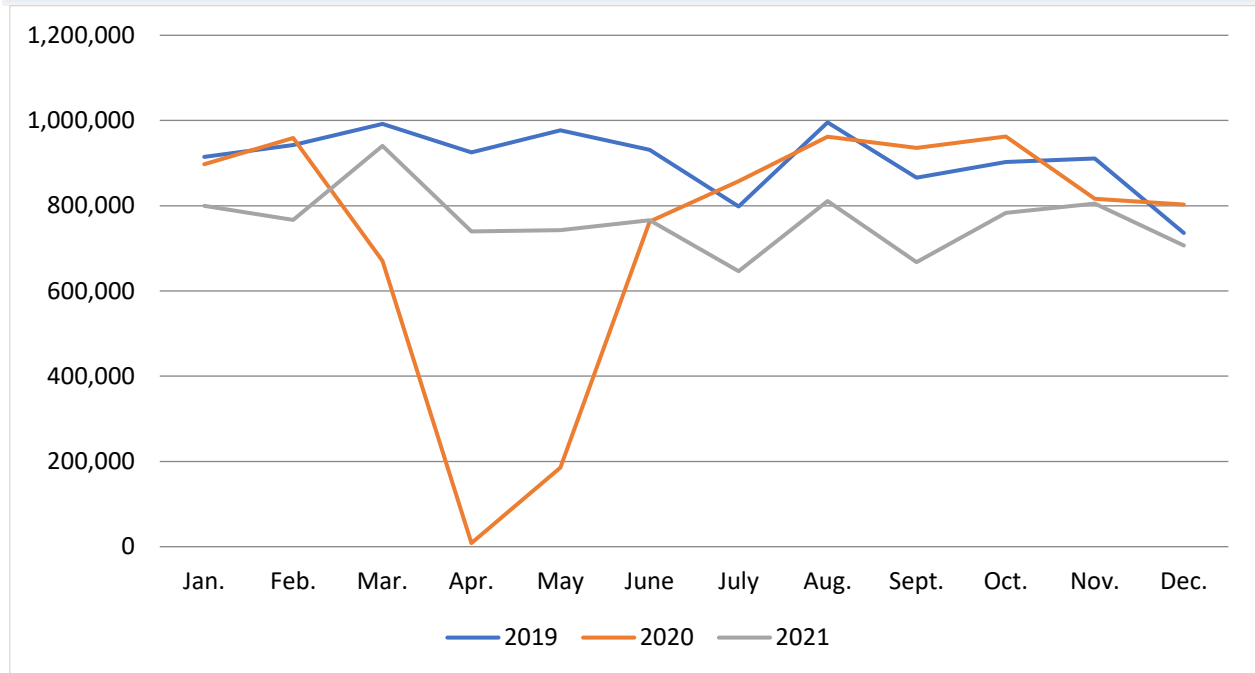
⁵ This paper focuses primarily on these two supply shocks. However, there were other non-supply factors (such as declining demand in 2020 and rising vehicle prices more recently) that were relevant as well.

⁶ As is consistent with USITC investigations, this paper defines domestic production as any production occurring in the United States, regardless of where the producer is headquartered. Light vehicles include cars, crossovers, minivans, sport-utility vehicles, and pickup trucks. It does not include heavy trucks or buses.

⁷ Szymkowski, “[COVID-19 shut down 93% of all U.S. Auto Production](#),” April 3, 2020’ Alliance For Automotive Innovation, “[Reading the Meter](#),” April 29, 2020. Note that this figure was prior to Kia halting operations on March 30 (Table 1).

U.S. light vehicle production in March declined by nearly 31 percent year-over-year (figure 1).⁸ There was very little light vehicle production in April, with just one plant open for one week at the end of the month. Mercedes-Benz was the first to reopen its plant on April 27, followed by BMW, Hyundai, Kia, and Volvo on May 4 (table 1).

Figure 1 U.S. vehicle production by month, 2019–21



Source: Ward’s Intelligence, “[U.S. Vehicle Production by Model by Month, 2020](#),” March 1, 2021; Ward’s Intelligence, “[U.S. Vehicle Production by Model by Month, 2019](#),” March 1, 2020; Ward’s Intelligence, “North American Vehicle Production by Month,” Various.

⁸ Ward’s Infobank. March 2019: 957,646 units, March 2020: 656,955.

Table 1 Shutdown and restart dates for light vehicle manufacturing in the United States

| Company | States with vehicle assembly | U.S. production shutdown date | U.S. production restart date |
|----------------------|------------------------------|-------------------------------|---|
| BMW | SC | March 19 | May 4 |
| FCA (now Stellantis) | IL, MI, OH | March 18 | May 18, May 26, and June 1 ^a |
| Ford | IL, KY, MI, MS, OH | March 18 | May 18 and May 25 ^b |
| GM | IN, KS, KY, MI, MS, TN, TX | March 18 | May 11 and May 18 ^c |
| Honda | AL, IN, OH | March 23 | May 11 |
| Hyundai | AL | March 18 | May 4 |
| Kia | GA | March 30 | May 4 |
| Nissan | TN, MS | March 20 | June 1 & June 8 |
| Mercedes-Benz | AL, SC | March 23 | April 27 |
| Subaru | IN | March 23 | May 11 |
| Tesla | CA | March 23 | May 11 |
| Toyota | IN, KY, MS, TX | March 18 | May 11 |
| Volkswagen | TN | March 21 | May 17 |
| Volvo | SC | March 26 | May 4 |

Sources: AMM, "[Production Suspension Schedules at U.S. Automotive Facilities](#)," accessed March 11, 2022; Blanco, "[All the Automakers Laying Off Workers During Coronavirus Pandemic](#)," April 9, 2020; Blanco, "[VW, FCA, Porsche, BMW Ready to Restart Car Production amid COVID-19](#)," May 1, 2020; Butler, "[Nissan Will Reopen its U.S. Manufacturing Plants Starting June 1](#)," May 27, 2020; Eisenstein, "[Hyundai, Kia Reopen US Plants](#)," May 5, 2020; McGee, "[Tesla to restart production in defiance of local officials](#)," May 11, 2020; Szymkowski, "COVID-19 and Plant Closures," May 8, 2020.

^a Some FCA parts plants did not reopen until May 26, and one assembly plant did not reopen until June 1 (Belvidere, IL).

^b One Ford assembly Plant (Flat Rock, MI) did not start back up until May 25.

^c GM largely reopened on May 18. However, two GM parts plants reopened the week prior on May 11.

The differences in production restart dates were primarily dictated by state-level restrictions regarding COVID-19. In total, between the decline in production in March and the lack of production in April, U.S. light vehicle production was already more than 1.5 million units behind its 2019 pace in 2020 (figure 1).⁹ Even after reopening, many plants were operating with only a single shift.¹⁰ The ramp up of production appeared to take several months, with average weekly hours for U.S. motor vehicles and parts employees not reaching 40 hours per week until July 2020.¹¹ Relatedly, after shutting down in mid-March, monthly U.S. vehicle production did not reach 2019 levels again until July (figure 1).¹²

U.S. vehicle production in 2020 totaled 8.8 million, more than 2 million less than 2019.¹³ Due to the growth in the global vehicle market in recent years, the temporary halt in production actually took more vehicles out of the global market than the entire two-year decline in production associated with the 2008-09 financial crisis.¹⁴ In the United States, 2020 year-end sales were 14.88 million units, almost 3

⁹ Ward's Intelligence, "[U.S. Vehicle Production by Model by Month, 2020](#)," March 1, 2021; Ward's Intelligence, "[U.S. Vehicle Production by Model by Month, 2019](#)," March 1, 2020.

¹⁰ Eisenstein, "[Hyundai, Kia Reopen US Plants](#)," May 5, 2020.

¹¹ Data for motor vehicles and parts (NAICS 3361, 3362, and 3363) pulled from BLS' "Employment Hours and Earnings from Current Employer. BLS, "Average Weekly Hours of All Employees," accessed January 7, 2022.

¹² Ward's Intelligence, "[U.S. Vehicle Production by Model by Month, 2020](#)," March 1, 2021; Ward's Intelligence, "[U.S. Vehicle Production by Model by Month, 2019](#)," March 1, 2020.

¹³ Ward's Intelligence, "[U.S. Vehicle Production by Model by Month, 2020](#)," March 1, 2021; Ward's Intelligence, "[U.S. Vehicle Production by Model by Month, 2019](#)," March 1, 2020.

¹⁴ Kahl, "[COVID-19 Could Result in at Least 20 Million Lost Vehicle Sales](#)," May 2020, 6.

million lower than 2019, and the lowest since 2012.¹⁵ U.S. vehicle production in 2021 was more stable than 2020, but did not reach the level of 2019, likely due to shortages of semiconductors and other components. Total U.S. vehicle production in 2021 totaled nearly 9.2 million units, 1.7 million short of 2019, and an average of 143,000 units less each month than 2019.

Arsenal of Health & Automotive PPE Production

As the COVID-19 pandemic spread across the United States, demand for personal protective equipment (PPE) and ventilators increased rapidly. In April 2020, the World Health Organization (WHO) estimated that 89 million face masks would be required each month to help protect hospital workers from the COVID-19 pandemic.¹⁶ In response to this, automobile manufacturers repurposed factories that had been shut down due to COVID to meet the sudden increase in demand for PPE due to COVID-19, with some calling it the “Arsenal of Health.”¹⁷ For example, under the Defense Production Act, Ford partnered with General Electric (GE), and General Motors (GM) worked with Ventec to manufacture critical care ventilators on automobile assembly lines for the Strategic National Stockpile (SNS). Ford and GE delivered 50,000 ventilators by July 2020 while GM and Ventec delivered 30,000 ventilators by August 2020.¹⁸

In addition to ventilator production, U.S. automakers met a significant share of growing demand for PPE nationwide.¹⁹ For example, as of October 2020, GM had produced 13 million face masks; 9 million of which were donated to public schools and hospitals. By December 2020, Fiat Chrysler (now Stellantis) had donated 10 million masks and 55,000 face shields – with 400,000 face masks and 30,000 face shields donated to Protect Native Elders, a nonprofit that assists people in tribal lands protect themselves during the pandemic.²⁰ Ford had donated 40 million face masks, 20 million face shields, and 1.5 million washable hospital gowns to organizations such as the Red Cross. In 2021, Ford donated over 120 million more face masks.²¹ Due to this mask production vehicle manufacturers were able to retain some workers as widespread shutdowns led to massive spikes in unemployment. As a result, while the pandemic also left many U.S. production workers furloughed with reduced or no pay during April and part of May, some employees volunteered to produce personal protective equipment (PPE).²²

¹⁵ Ward’s Intelligence, “[U.S. Total Vehicle Sales by Company](#),” March 1, 2021.

¹⁶ Asian Development Bank, “[Global Shortage of Personal Protective Equipment amid COVID-19: Supply Chains, Bottlenecks, and Policy Implications](#),” April 2020.

¹⁷ The Arsenal of Health is a reference to the Arsenal of Democracy, a term coined during World War 2 when U.S. automakers shifted to the production of tanks, planes and other military equipment. For more information, see Wayland, “[How Detroit automakers are creating a new ‘arsenal of health’ to cope with growing coronavirus pandemic](#),” April 3, 2020.

¹⁸ USITC, “[COVID-19 Related Goods: The U.S. Industry, Market, Trade, and Supply Chain Challenges](#),” December 2020.

¹⁹ Vousden, “[Mapping the auto manufacturers building PPE and medical equipment to battle COVID-19](#),” April 17, 2020 (subscription required); Wayland, “[How Detroit automakers are creating a new ‘arsenal of health’ to cope with growing coronavirus pandemic](#),” April 3, 2020.

²⁰ Valdes-Dapena, “[Automakers are still cranking out masks and other PPE as Covid roars back](#),” December 8, 2020.

²¹ Cerullo, “[How companies pivoted from making dresses, snowboards and whisky to face masks, gloves and sanitizer](#),” March 20, 2021.

²² Wayland, “[How Detroit automakers are creating a new ‘arsenal of health’ to cope with growing coronavirus pandemic](#),” April 3, 2020.

Production Workers Furloughed or Receiving Reduced Pay

Most U.S. light vehicle production workers were furloughed at some point in early April but continued to receive health benefits from their employer and unemployment benefits from either their union contract or state and federal programs. The major exception was that some paid volunteers from among the vehicle manufacturers' workforce pivoted to producing the previously mentioned PPE equipment.²³ Motor vehicle and parts employment data shows a decline of more than 450,000 workers from March 2020 to April 2020, implying more than 40 percent of such workers were furloughed or let go due to the pandemic.²⁴ Detroit Three production employees that were not called back to produce PPE received 75 percent of their wages through "unemployment and supplemental unemployment benefits according to their UAW contract."²⁵ Further, through the CARES Act, Congress approved increasing unemployment benefits by \$600/week and extending unemployment benefits by up to 13 weeks, which many of the furloughed workers were able to access.²⁶ Similarly, in many European countries furloughed workers received up to 80 percent of their private sector salaries.²⁷ In contrast, some vehicle manufacturers operations in some developing countries, were required to continue paying employees even though the plants were shut down because there was no unemployment insurance or other payment schemes to support workers.²⁸

Supply Chain Disruptions

Vehicle manufacturers were also concerned about their global supply chains. As the pandemic abated in different regions, supplier plants reopened. First, supplier plants in China reopened in March and April, but many in Europe continue to be shut down until late April.²⁹ Volkswagen expressed concern that parts suppliers would have to charge more for parts because they were selling fewer parts than planned.³⁰ ZF, a German supplier with plants in the United States, announced plans to cut its global workforce by 10 percent in late May 2020.³¹ These disruptions to the global supply chain affected U.S. manufacturing: Mercedes-Benz restarted its Vance, AL plant on April 27, but had to temporarily stop production on May 15 due to parts shortages.³² Periodic shutdowns of automotive parts suppliers and ports due to pandemic outbreaks continued to affect automotive supply chains through 2021.

²³ Wayland, "[How Detroit automakers are creating a new 'arsenal of health' to cope with growing coronavirus pandemic](#)," April 3, 2020.

²⁴ BLS, "Current Employment Statistics," (accessed May 5, 2022). This data is monthly data not seasonally adjusted for all employees in NAICS code 3361 Motor Vehicles and Parts.

²⁵ Blanco, "[All the Automakers Laying Off Workers During Coronavirus Pandemic](#)," April 9, 2020.

²⁶ DOL, "[Unemployment Insurance Relief During COVID-19 Outbreak](#)," (accessed May 5, 2022); Blanco, "[All the Automakers Laying Off Workers During Coronavirus Pandemic](#)," April 9, 2020.

²⁷ Birnbaum, Booth, and Beck, "[Europe Pays High Price](#)," October 10, 2020.

²⁸ Campbell and Miller, "[Carmakers hit by lack of state support in emerging markets](#)," April 26, 2020.

²⁹ Li and Jian, "[Reopening the World](#)," June 16, 2020; Reuters, "[European Carmakers Restart Production](#)," April 26, 2020.

³⁰ Miller, "[Volkswagen Warns of Rising Costs](#)," May 5, 2020.

³¹ Miller, "[German Car Parts Group to Axe up to 15,000 Jobs](#)," May 29, 2020.

³² Bouchette, "[Autoworkers Are Returning](#)," May 17, 2020.

Some smaller parts suppliers reached the brink of closure while assembly plants were shut down, and there was concern that some would not have the money necessary to reopen without assistance.³³ One of the big challenges for automotive parts suppliers is having money available to spend on the capital-intensive process of restarting production. Parts suppliers are usually paid for completed work in 30, 60, or 90-day periods, but because of how long companies were shut down they restarted production at a time when no money was coming in.³⁴

Vehicle manufacturers and Tier 1 suppliers³⁵ monitored their supply chains closely, with at least one Tier 1 supplier (Delphi, a producer of automotive systems) supporting two of its suppliers by either purchasing raw materials for them or expediting payment. Due, at least in part, to government programs and actions by larger companies, most parts suppliers were able to start back up in May 2020. Many of the smaller parts suppliers were eligible for Paycheck Protection Program loans.³⁶ At least some companies were acquired because they faced insolvency. For example, Grede acquired a foundry in Milwaukee from RMG Waukesha for its related contracts and tooling, and planned to close the Milwaukee-based foundry and transfer toolings to other Grede-owned foundries.³⁷ Among 347 companies that listed the pandemic as, at least in part, responsible for their bankruptcy, only eight of them were automotive parts suppliers (table 2).³⁸ The industry as a whole accumulated \$72 billion in debt between March and July of 2020.³⁹

Table 2 Automotive parts suppliers that filed for bankruptcy due to the pandemic in 2020

| Company | Assets | Automotive parts |
|-----------------------------|--------|--|
| Garrett Motion | 2.1B | Turbochargers |
| Shiloh Industries | 664.2M | Lightweighting |
| Exide Technologies | 500.0M | Lead-acid batteries |
| APC Automotive Technologies | 100.0M | Underbody vehicle products |
| Techniplas | 100.0M | Plastic components |
| Pace Industries | 100.0M | Die cast components |
| Miller Tool & Die | 1.0M | Tool and die |
| Krieger Craftsmen | 1.0M | High precision plastic injection molds |

Sources: Scigliuzzo et al, "[The Covid Bankruptcies](#)," December 31, 2020; Garrett, [Company Website](#), accessed December 23, 2021; Shiloh Industries, [Company Website](#), accessed December 23, 2021; Exide Technologies, [Company Website](#), accessed December 23, 2021.
 Note: Many of these companies restructured and came back out of bankruptcy several months later.

The Semiconductor ‘Chip’ Shortage

Before discussing the shortage, it’s important to state that the amount and sophistication of semiconductor chips (“chips”) in automobiles has increased over time. In conventional automobiles,

³³ Carey and Klayman, "[May Is Crunch Time for U.S. Auto Suppliers](#)," April 9, 2020.

³⁴ Wayland, "[It’s Trying Times for U.S. Auto Suppliers as Plants Reopen](#)," May 17, 2020.

³⁵ Tier 1 suppliers are parts suppliers that produce automotive systems that they send directly to the vehicle manufacturer. Tier 2 suppliers produce components that are used in automotive systems, and tier 3 suppliers supply natural resources such as steel or aluminum to vehicle manufacturers, tier 1, and tier 2 suppliers.

³⁶ Manufacturers received nearly \$54 billion in Paycheck Protection Program loans, but its unknown what percentage went to parts suppliers. SBA, "[Paycheck Protection Program Report](#)," May 30, 2020.

³⁷ Irwin, "[Castings Supplier Grede Purchases Wisconsin Foundry](#)," June 5, 2020.

³⁸ Scigliuzzo et al, "[The Covid Bankruptcies](#)," December 31, 2020.

³⁹ Lampinen, "[Corporate Debt Piles up as CASE and COVID-19 Challenges Collide](#)," July 2020, 61.

chips process information in various vehicle subsystems that improve a vehicle's efficiency or make driving safer. Additionally, rising adoption of electric vehicles has contributed to increased demand for automotive semiconductor chips because electric vehicles need a higher number of chips per vehicle than conventional automobiles.⁴⁰ For more information about the semiconductor industry and the relation to automobiles, please see Box 1.

Box 1 The Semiconductor Industry and Importance of Automotive Semiconductors

The combination of a concentrated semiconductor fabrication industry and high demand for chips contributed to a shortage that negatively impacted the automotive industry. The automotive industry faces a tier 3 supplier issue concerning the sourcing of chips.^a Put plainly, automotive OEMs source their semiconductors from firms that outsource manufacturing. The outsourcing of chip manufacturing resulted in TSMC, the world's largest chipmaker, producing approximately 70 percent of all automotive microcontroller units (MCUs) in 2020.^b TSMC's Chairman, Mark Liu, attributed the chip shortage to COVID-19 disruptions, trade action uncertainty, and accelerated digital transformation.^c

The semiconductor industry ("chipmakers") are split between firms that are integrated device manufacturers and firms operating with a foundry model. Integrated device manufacturers, (e.g., Intel, Samsung, and Texas Instruments) design and manufacture chips. In contrast, foundry firms either design or manufacture chips. Firms that only design chips are known as fabless companies (e.g., AMD, Apple, and Nvidia). Fabless companies contract manufacturing with firms that specialize in fabricating chips (e.g., TSMC and GlobalFoundries). After manufacturing, chipmakers send chips to intermediate firms to assemble, package, and test the final products.^d

Chips are a near essential component to automobiles. Conventional vehicles had approximately \$330 worth of chips in 2019.^e This number has likely increased in the last two years. The largest share of automotive chips are in MCUs that enable vehicle electrification by replacing manual systems (e.g., windows and locks), managing vehicle sensors (e.g., fuel levels or oil change indicators), and improving vehicle performance.^f Beyond MCUs and sensors, high-end vehicles use more powerful chips to run safety and driver assistance features, entertainment systems, and connectivity technologies.^g

Despite the prevalence of chips in vehicles, automotive demand makes up less than 10 percent of chip revenue. Chip sales to automotive producers accounted for \$41 billion in 2019 or 9.4 percent of chip sales by application.^h The automotive industry uses large numbers of non-leading-edge chips, which tend to cost less and have lower profit margins than leading-edge chips.ⁱ Other applications like power management systems and 5G radio transponders use similar chips.^j

The semiconductor industry struggled to keep pace with demand throughout the COVID-19 pandemic. Lockdowns pushed businesses and individuals to work and learn remotely, which increased demand for computers, peripherals, other electronic devices, and servers. The World Semiconductor Trade Statistics found that the semiconductor market grew 6.8 percent in 2020 and projected the industry to grow 25.6 percent in 2021.^k In an attempt to keep up with demand, chip manufacturers increased capacity utilization with U.S. firms reporting an average capacity utilization rate of 88 percent in 2020 and 2021.^l It should be noted that higher capacity utilization rates require longer-run times and minimal downtime. Changing products is a relatively lengthy process for semiconductor manufacturers. For instance, chipmakers may need four months to retool a manufacturing line to make previously made chips.^m

⁴⁰ The average EV has 2.3 times the semiconductor content of a vehicle with an internal combustion engine. Gear, "[EV Power Electronics](#)," September 23, 2021.

While a shortage is likely to continue in the short-term, chipmakers are investing in long-term solutions that will meet future demand for chips. Beyond raising capacity utilization rates, chipmakers have limited short-term options to increase output. For instance, chipmakers may increase capacity by moving production to a different manufacturing site, but doing so takes six months.ⁿ Purchasers could source from different chip manufacturers, but the process may take a year or more and increase costs. Additionally, these time estimates do not include the vehicle manufacturer's qualification process that could add six months to a year for new suppliers.^o Constructing a new chip foundry, even for a mature technology such as automotive semiconductors, costs billions and take years to construct, test, and validate.^p Despite the time needed and high costs, chipmakers are building new foundries to lessen the chip shortage.^q

^a Leonard, "[Why the Automotive Supply Chain](#)," February 23, 2021.

^b Leonard, "[Why the Automotive Supply Chain](#)," February 23, 2021.

^c AutoTech News, "[TSMC's Chairman](#)," April 18, 2021.

^d AnySilicon, "[Outsourced Semiconductor Assembly and Test](#)," accessed January 14, 2022.

^e Electric vehicles require more chips valued between \$1,000 and \$3,500 per vehicle. Lawrence and VerWey, "[The Automotive Semiconductor Market](#)," May 2019.

^f AZO Materials, "[How Are Semiconductors Used in Cars?](#)," April 26, 2021.

^g AZO Materials, "[How Are Semiconductors Used in Cars?](#)," April 26, 2021; Kumar, "[Semiconductor Devices for Automobiles](#)," September 17, 2021.

^h Burkacky et al, "[Coping with the Auto-Semiconductor Shortage](#)," May 27, 2021.

ⁱ A non-leading-edge chips using transistors larger than 28 nanometers. Transistor size is negatively correlated with processing power. Burkacky et al, "[Coping with the Auto-Semiconductor Shortage](#)," May 27, 2021.

^j Burkacky et al, "[Coping with the Auto-Semiconductor Shortage](#)," May 27, 2021.

^k World Semiconductor Trade Statistics, "[WSTS Semiconductor Market Forecast Fall 2021](#)," November 30, 2021.

^l The industry considers 80 percent near full utilization. Census, "[Quarterly Survey of Plant Capacity Utilization](#)," accessed January 14, 2022; and Ravi, "[Chipmakers Are Ramping Up Production](#)," February 26, 2021.

^m Burkacky et al, "[Coping with the Auto-Semiconductor Shortage](#)," May 27, 2021.

ⁿ Burkacky et al, "[Coping with the Auto-Semiconductor Shortage](#)," May 27, 2021.

^o Burkacky et al, "[Coping with the Auto-Semiconductor Shortage](#)," May 27, 2021.

^p Ludwikowski and Sjoberg, "[Semiconductor Shortage and the U.S. Auto Industry](#)," June 22, 2021.

^q Intel, "[Intel Announces Next US Site](#)," January 21, 2022; Samsung, "[Samsung Electronics Announces New Advanced Semiconductor](#)," November 24, 2021; TSMC, "[TSMC Announces Intention to Build](#)," May 15, 2020.

Just as the automotive industry returned from COVID shutdowns in mid-2020, supply chain challenges and temporary shortages began to limit production of light vehicles. These supply chain issues continued limiting production, and thus sales, of vehicles through the rest of 2020 and throughout 2021. The most prominent, and long-lasting of these challenges has been the semiconductor chip shortage. This shortage, which started as a result of expectations that automotive production would not bounce back as quickly as it did, has proven to have more of a lasting impact, because existing chip capacity went to other products, and overall semiconductor demand has increased significantly. This section explains the causes of the shortage, the short-term responses by vehicle manufacturers, and the long-term impact of the shortages.

What Caused the Semiconductor Shortage?

At the onset of COVID-19, chipmakers pivoted their production lines from making automotive to electronics chips due to rising chip demand. This pivot was due to canceled automotive semiconductor orders, and increased demand for semiconductors used in consumer products.⁴¹ Many vehicle manufacturers canceled their orders with the expectation that vehicle demand would decline

⁴¹ Priddle, "[What Happened with the Semiconductor Chip Shortage](#)," December 27, 2021.

significantly. However, vehicle demand bounced back relatively quickly in April 2020.⁴² The shock was exacerbated because vehicle manufacturers kept low chip inventories.⁴³

In response to the cancelled orders, semiconductor manufacturers pivoted to make chips for industries with increasing demand, such as telecommunications and consumer electronics. Overall semiconductor demand increased by between 5 and 9 percent in 2020, despite automotive demand for semiconductors declining by 15 percent.⁴⁴ Semiconductor manufacturers that previously supplied vehicle manufacturers began to make chips for the 5G rollout and power-electronic chips, which use chips with similar node sizes to those needed in vehicle electrification and have higher prices.⁴⁵ This production shift resulted in a lack of capacity to fulfill automotive orders when the auto industry re-started production a few months later. To address the shortfall of chips, semiconductor manufacturers re-tooled their fabrication plants to increase capacity utilization.⁴⁶ However, semiconductor shortages continue to be a bottleneck for vehicle manufacturers.⁴⁷

This automotive semiconductor shortage has continued for several reasons, including increased demand for semiconductors, contract term mismatches, limited available semiconductor capacity, and automotive semiconductors not being the most appealing option for semiconductor manufacturers. As mentioned earlier, semiconductor demand in other industries increased significantly. In terms of supply chain management, semiconductor and automotive manufacturers are not well aligned. Efficient semiconductor manufacturing requires long-term commitments to maximize output. In contrast, the automotive industry may need to adjust their chip purchases a few weeks ahead of production.⁴⁸

How Have Vehicle Manufacturers Responded?

Vehicle manufacturers attempted to mitigate the effects of the chip shortage through a variety of ways: 1) temporarily stopping or slowing production; 2) prioritizing chips in high margin vehicles; 3) build-shy (i.e. building as much of the vehicle as possible then waiting for chips); 4) reducing semiconductor content in vehicles; and 5) over-ordering and stockpiling chips. First, some vehicle manufacturers have had to slow or stop production due to a shortage of chips.⁴⁹ Global production in 2021 increased by 2.5 million units (80.1 million to 77.7 million) compared to 2020, but was well below the production level of 2019 (91.7 million).⁵⁰ Second, vehicle manufacturers also sought to use what chips they had available in higher margin vehicles such as pickup trucks and SUVs.⁵¹ Some manufacturers such as GM and Ford

⁴² LaReau, "[Everything You Need to Know About the Chip Shortage](#)," June 15, 2021.

⁴³ Burkacky et al, "[Coping with the Auto-Semiconductor Shortage](#)," May 27, 2021.

⁴⁴ Burkacky et al, "[Coping with the Auto-Semiconductor Shortage](#)," May 27, 2021.

⁴⁵ Burkacky et al, "[Coping with the Auto-Semiconductor Shortage](#)," May 27, 2021.

⁴⁶ Please note that semiconductor capacity utilization is above the 80 percent considered to be "near full utilization." For instance, capacity utilization reached 95 percent in Q3 2020 and this trend is significantly higher than pre-pandemic rates. Semiconductor Industry Association, "[Chipmakers are Ramping Up Production](#)," February 26, 2021.

⁴⁷ Choo, "[Around the Tracks](#)," March 10, 2022; Foote, "[2022 Ford Super Duty Production Once Again Impacted](#)," March 4, 2022; Root, "[GM Is Idling a Plant](#)," March 25, 2022.

⁴⁸ Burkacky et al, "[Coping with the Auto-Semiconductor Shortage](#)," May 27, 2021.

⁴⁹ LaReau, "[Everything You Need to Know About the Chip Shortage](#)," June 15, 2021; AlixPartners, "[Shortages Related to Semiconductors](#)," September 23, 2021.

⁵⁰ OICA, "[Production Statistics](#)," accessed March 16, 2022.

⁵¹ Klayman and Carey, "[GM's Barra Sees A More Profitable Future](#)," May 5, 2021.

reportedly used a build-shy strategy with many of their trucks, building as much as they could of tens of thousands of trucks, then storing them while waiting for the necessary chips.⁵² Another strategy employed by some manufacturers was to reduce chips per vehicle in order to enable them to produce more vehicles with the chips they currently had available to them. For example, GM built some light duty pickup trucks without a fuel management module and Tesla removed the ability to adjust lower lumbar support from the passenger vehicle of its Model 3's.⁵³ BMW, Mercedes-Benz, Stellantis, and Mitsubishi also limited the availability of optional equipment or adjusted specifications of vehicles.⁵⁴ Some vehicle manufacturers have also placed orders with multiple chip suppliers (above what they need) in the hopes that one of those suppliers will be able to supply chips faster than the others.⁵⁵

Vehicle manufacturers have also taken some actions that they believe will help them weather future semiconductor supply chain disruptions. For example, Ford has begun designing its own chips, and is exploring jointly investing with a chip foundry in expanding production.⁵⁶ Meanwhile, GM is reducing the number of varieties of chips needed by 95 percent, with a focus on three types of microprocessors. GM believes this will help increase chip supply while reducing costs.⁵⁷ It likely also makes it less likely that a disruption of a small percentage of chips would force major production changes, as the chips will be more interchangeable.

Impact on the Automotive Sector

The closures due to COVID and the semiconductor chip shortage negatively affected automotive production, sales, and trade in the United States and around the world. The following three sections will breakdown U.S. light vehicle sales, U.S. light vehicle trade, and global vehicle production.

Sales Declined Significantly

Despite the rebound in the second half of the year as plants reopened and demand picked back up, U.S. auto sales declined sharply in 2020 with sales of new vehicles dropping by more than 15 percent compared to 2019— the worst annual decline since 1980.⁵⁸ Through June, U.S. light vehicle sales were nearly 2 million units (23.4 percent) lower than the first six months of 2019, and nearly 3 million by year-end.⁵⁹ Specifically in the second quarter of 2020, sales declined at levels not seen since the Great Recession. For example, the United States' largest automaker, GM, saw a 34 percent drop in sales, Ford recorded a 33 percent decline in sales, and Toyota reported a 35 percent decline in sales in Q2 of 2020.⁶⁰

⁵² LaReau, "[GM Build-Shy Strategy](#)," May 6, 2021.

⁵³ LaReau, "[GM Build-Shy Strategy](#)," May 6, 2021; Yekikian, "[Tesla Model 3 and Y Lose Adjustable Lumbar](#)," June 4, 2021.

⁵⁴ Preston, "[Some Automakers Say the Chip Shortage](#)," November 19, 2021.

⁵⁵ Whalen, "[Semiconductor Shortage](#)," September 23, 2021; Azeez, "[Carmakers Hoarding Semiconductors](#)," July 13, 2021.

⁵⁶ Boudette and Clark, "Ford Moves to Ensure Supply of Chips," November 18, 2021.

⁵⁷ Boudette and Clark, "Ford Moves to Ensure Supply of Chips," November 18, 2021.

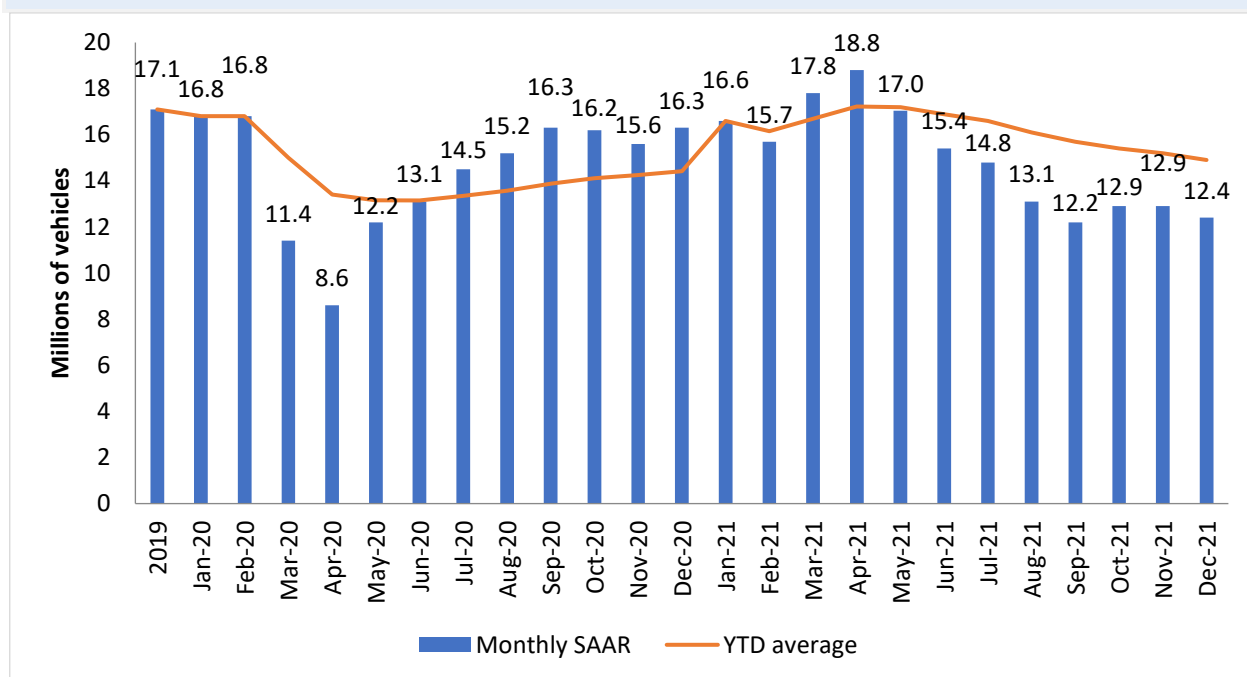
⁵⁸ Wayland, "[Coronavirus Crippled U.S. Auto Sales in 2020 but it Could Have Been Far Worse](#)," December 23, 2020.

⁵⁹ [Ward's Intelligence, "U.S. Car and Light Truck Sales by Model by Month, 2020," January 31, 2022; Ward's Intelligence, "U.S. Light Vehicle Sales, June 2020," July 1, 2020.](#)

⁶⁰ Wayland, "[Ford sales fall 33.3% in the second quarter due to coronavirus](#)," July 2, 2020. Isidore, Chris, [US Car Sales just had Their Worst Quarter Since the Great Recession](#)," July 1, 2020.

Fiat Chrysler also announced a 39 percent decrease in revenue citing the drop in rental fleet sales as a major driver of lost sales.⁶¹ The U.S. seasonally adjusted annual rate (SAAR) for light vehicle sales in April was 8.58 million units, the lowest recorded in the Ward’s database, which goes back to January 1980 (figure 2).⁶² Sales improved in the third quarter of 2020, but were still down more than 9 percent compared to 2019. Major automakers such as GM (9.9 percent decline), Fiat Chrysler (10.2 percent decline), and Ford (4.9 percent decline) saw significant improvements compared to the second quarter of 2020 however.⁶³ Light vehicle sales in 2021 were 500,000 units higher than 2020, but still two million short of 2019.⁶⁴ This lack of sales was relatively consistent throughout the year, instead of a couple of below-average months, likely because the semiconductor shortage affected sales throughout the year.

Figure 2 U.S. light vehicle sales, SAAR, 2019–21



Source: Manzi, “[Market Beat](#),” January 2020–December 2021.

Note: 2019 value shown is the year-end 2019 average. Values shown for 2020 and 2021 are monthly SAAR. Line depicts the YTD average for the SAAR each month.

This decline in sales, particularly in 2021, seems to have been primarily driven by a shortage in supply, as evidenced by high prices and profit margins for vehicle manufacturers, as well as low inventories. The average transaction price for new vehicles passed \$45,000 for the first time in September 2021.⁶⁵ Low inventories, and a sales mix that included more expensive pickup trucks, SUVs, and luxury vehicles were said to drive the price increase.⁶⁶ As discussed earlier, vehicle manufacturers have prioritized production of these more expensive vehicles due to a shortage of semiconductors.

⁶¹ Isidore, “[US Car Sales just had Their Worst Quarter Since the Great Recession](#),” July 1, 2020.

⁶² Ward’s Intelligence, “U.S. SAAR History,” May 2020.

⁶³ Irum, and Hudgins, “[US auto sales down 9% in Q3 as coronavirus continues to curb demand](#),” October 13, 2020.

⁶⁴ [Ward’s Intelligence, “U.S. Vehicle Sales by Model, 2017-2021,” January 31, 2022.](#)

⁶⁵ Kelley Blue Book, “[Average New-Vehicle Transaction Prices Top \\$45,000](#),” October 13, 2021.

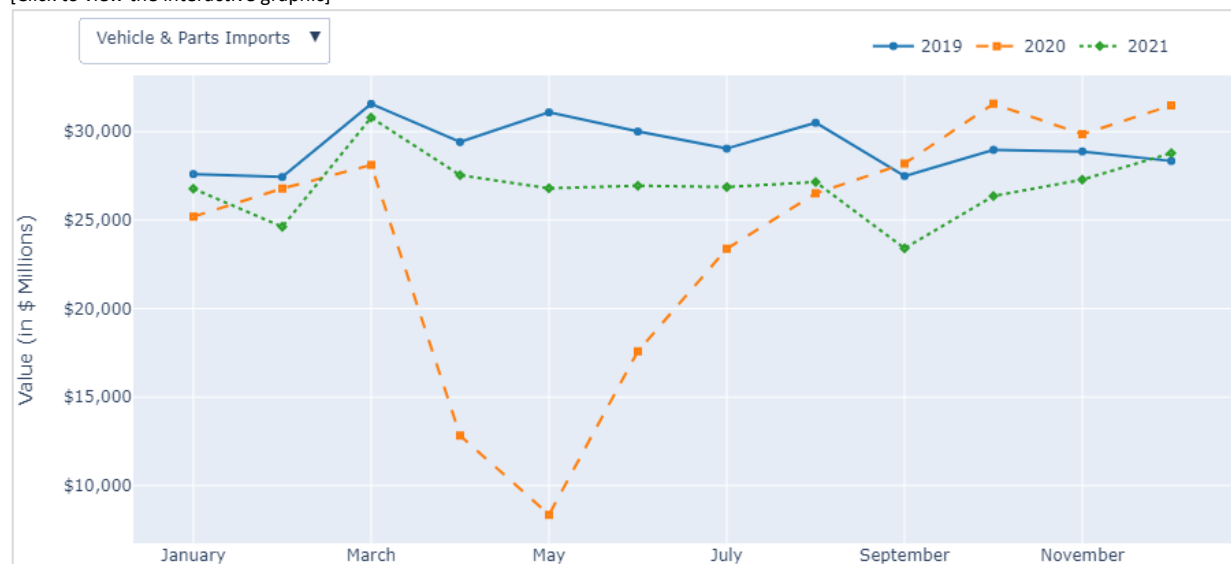
⁶⁶ Kelley Blue Book, “[Average New-Vehicle Transaction Prices Top \\$45,000](#),” October 13, 2021.

Trade Declined Significantly

Trade in the automotive sector has also significantly declined in 2020 and 2021 due to the aforementioned pair of supply shocks.⁶⁷ Figure 3 shows monthly import and export data for both automobiles and automotive parts (you can dig into the data in the interactive graphic located here). While the February 2020 trade data looks comparable with previous years, exports in March 2020 were down \$860 million (automobiles) and \$1.5 billion (parts) compared with 2019 (figure 3) due to the initial plant closures and production stoppages. In April 2020 the difference was even more pronounced, with exports declining by \$4.3 billion for automobiles and \$5.0 billion for auto parts. Through April, year-to-date exports were down \$4.6 billion for automobiles and \$7.1 billion for auto parts, compared with 2019. Exports rebounded sharply as factories reopened in May but remained consistently lower throughout the remainder of 2020 compared to 2019. In total, U.S. exports were down \$13.4 billion for vehicles (19.6 percent), and \$18.3 billion for vehicle parts (21.7 percent), in 2020 compared to 2019.

Figure 3 Automotive trade, 2019–21, million \$

[Click to view the interactive graphic]



Source: USITC DataWeb/Census, HTS 8703.21, 8703.22, 8703.23, 8703.24, 8703.31, 8703.32, 8703.33, 8703.40, 8703.50, 8703.60, 8703.70, 8703.80, 8703.90, 8704.21, and 8704.31. accessed February 16, 2022. The HTS statistical reporting numbers used for automotive parts is consistent with the most recent list published by the [U.S. Department of Commerce International Trade Administration's Office of Transportation and Machinery](#).

Turning to 2021, the lingering chip shortage appears to have impacted vehicle parts exports more than vehicle exports. While vehicle exports by month rivaled those of 2019 (and in some months even surpass pre-pandemic totals), vehicle parts exports were consistently around \$1 billion lower than their 2019 equivalent. Total U.S. exports were only down \$3.0 billion (4.3 percent) in 2021 (compared to 2019) for vehicles, while vehicle parts exports were still down \$14.1 billion (16.8 percent).

⁶⁷ As mentioned previously, there other factors impacting the automotive industry throughout 2020 and 2021 in addition to the two supply shocks. Other factors related to the decline in trade include the decline in global demand for transportation in 2020, and the more prolonged global shipping disruptions.

For imports, the story is initially quite similar; February trade data looks stable year-over-year, but March imports are noticeably down when comparing 2020 to 2019 (\$2 billion for automobiles, and \$1.7 billion for auto parts, see figure 3).⁶⁸ Moreover, as with exports, the decline in April was far greater. Imports declined \$9.7 billion for vehicles and \$6.8 billion for parts when comparing April 2020 with April 2019. Through April, year-to-date imports were down \$14.6 billion for automobiles, and \$9.6 billion for auto parts, compared with 2019. However, things begin to deviate compared to exports because, while imports of both vehicles and vehicle parts rebounded for the rest of 2020, vehicle imports from September 2020 onward actually outpaced their 2019 equivalents, and vehicle parts imports also surpassed their 2019 totals in October and November. Despite this rebound, total U.S. imports were down \$37.8 billion for vehicles (18.8 percent), and \$22.7 billion for vehicle parts (15.2 percent), in 2020 compared to 2019.

Vehicle imports however reverted to lagging behind their 2019 monthly totals throughout 2021 but did not suffer the same dramatic decline as March/April 2020, as the chip shortage created a consistent shortage in the supply of vehicles globally. On the year, U.S. vehicle imports in 2021 were down \$31.8 billion (15.8 percent) compared to 2019. Vehicle parts imports, however, were near or above 2019 levels each month of the year, and in total actually surpassed 2019 levels by \$4.8 billion (3.2 percent). The relatively high level of parts imports may support reports of “build-shy” strategy by manufacturers where they built vehicles without some needed semiconductors then stored the vehicles until they received the necessary semiconductors.

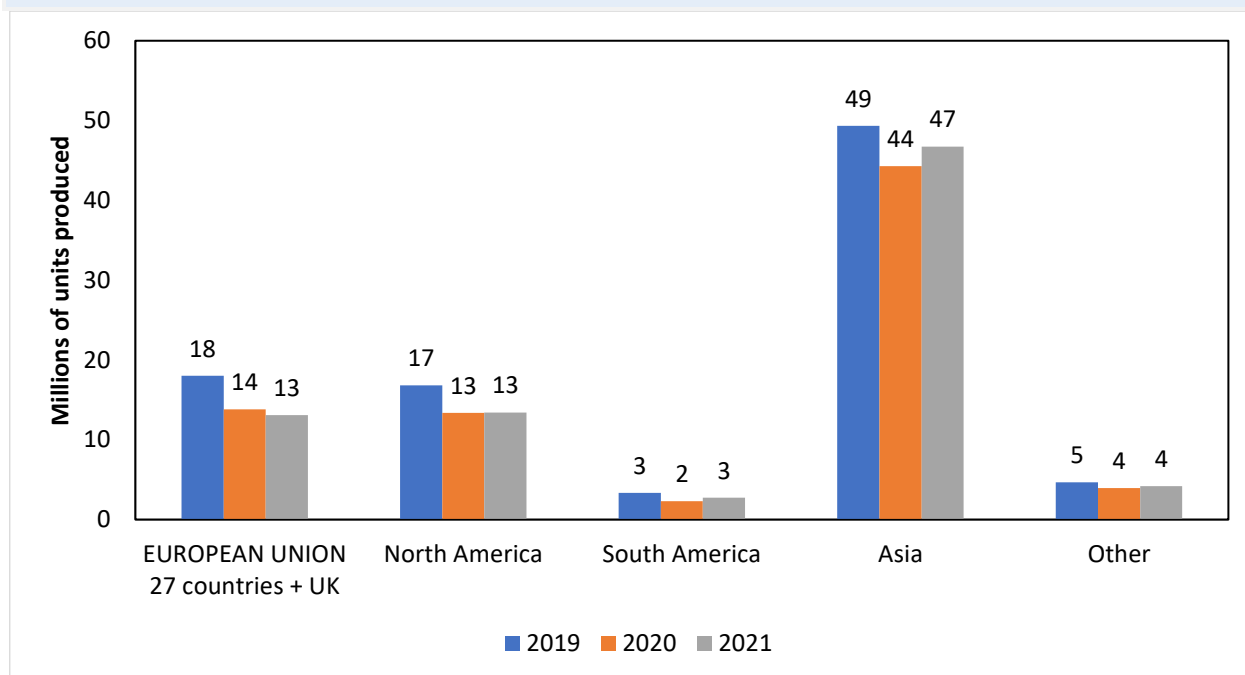
Vehicle Production Declined Around the Globe

Around the world, the auto industry was hit by COVID-19. Responses varied from country to country, and widespread shutdowns brought auto plants to a stand-still. In 2020, the global auto industry saw production cuts, supply shortages, and interventions from governments. Global production declined by nearly 15 million units (16 percent) from 92.2 million in 2019 to 77.7 million in 2020.⁶⁹ The reduction in output, however, was not uniform across regions, with declines in production of greater than 20 percent in Europe and North America, but only 10 percent in Asia (figure 4). Among countries that produced more than a million units each year, Chinese production was the only country with even a slight increase (1 percent) from 2019 to 2021, and the largest declines occurred in Canada (-42 percent) and France (-38 percent).⁷⁰ Production continued to be limited in 2021, with an increase to 80 million units produced, but the semiconductor shortage prevented a full bounceback. While production increased in Asia and South America, it decreased slightly in North America and Europe.

⁶⁸ It's worth noting that imports of automobiles did increase from February to March this year.

⁶⁹ OICA, “Production Statistics,” accessed March 18, 2022.

⁷⁰ OICA, “Production Statistics,” accessed March 18, 2022.

Figure 4 Vehicle production by region, 2019–21

Source: OICA, “Production Statistics,” accessed March 18, 2022.

Conclusion

The U.S. automotive industry experienced two major disruptions related to the onset of the COVID-19 pandemic. While the initial shutdowns of plants and halting of production in March and April of 2020 may have been the more severe external shock to the industry, the direct effect of the shutdowns on vehicle production was relatively short-lived and, by May, production had restarted.

However, soon after the restarting of U.S. automotive production, the industry faced newfound supply chain shortages in the form of the prolonged semiconductor chip shortage, which has had (and continues to have) a more lasting impact on the industry’s ability to produce and supply vehicles to the U.S. market. The shortage has sparked various mitigation strategies and innovations on the part of vehicle producers, as they pursued ways of minimizing the negative impact of the shortage including prioritizing the most profitable production, removing optional features, and “build-shy” production.

These two shocks to the U.S. automotive industry resulted in significant disruptions to sales, production and trade. While sales in 2021 have rebounded compared to 2020, they still lag behind 2019 by 2 million vehicles. Production shows a similar pattern, as does international trade. While March and April of 2020 had the largest year-over-year changes across each metric, the impacts have been prolonged, with only imports of vehicle parts up in 2021 compared to 2019.

There were certainly other factors that affected the automotive industry during this time period, but this paper focused on these two supply shocks. Other factors that were not closely examined were shipping disruptions after May 2022 that could be attributed to the aftereffects of the onset of the COVID-19 pandemic, and the effect of the transition from internal combustion engine vehicles to electric vehicles, which has been happening simultaneously. While the shipping disruptions likely acted as an additional drag on production and trade, it’s unclear what effect the transition to electric vehicles may have had on production or trade.

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