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Overview of the U.S. Automobile Industry

Thomas Klier and James Rubenstein

Introduction

The car was not invented in the United States, but it was there that nearly universal ownership of vehicles was first embraced. The United States is also the first country to adopt mass production of cars. As recently as 1950, more than one-half of the world's vehicles were registered in the United States, and more than three-fourths of the world's vehicles were produced in the United States that year. Into the twenty-first century, the United States is no longer the world's leading producer of vehicles, but, with 21 percent of the world's vehicles in use in 2015 (International Organization of Motor Vehicle Manufacturers 2018), it remains one of the largest markets.

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This chapter provides an overview of the U.S. auto industry. We start by discussing the major disruptive forces currently facing the industry. In the second and third sections, we focus on the market for vehicles as well as different aspects of the production of vehicles. Section four briefly discusses the role of the government. We conclude with providing a brief outlook for the industry.

Three Disruptions

The U.S. (as well as the entire world) auto industry is likely to be sharply altered by three major disruptions: electrification, autonomy, and sharing.[1] These trends present significant challenges for the current producers of vehicles and vehicle parts and have encouraged new entrants to vehicle production. Yet, given the complexity and need for coordination in designing and producing a car, MacDuffie and Fujimoto (2010) conclude, "[the established companies] that can successfully wage war on complexity are positioned to beat new challengers for at least the next few decades" (MacDuffie and Fujimoto 2010).[2]

Electrification

The United States was the world's first leading market for electric vehicles, with annual sales of around 200,000 in 2017 and around 765,000 on the road, one-fourth of the worldwide total (Cobb 2015; Lutsey 2015; "Monthly Plug-in Sales Scorecard" 2018; Vaughan 2017). This figure includes plug-in electrics (PEVs), such as the Nissan Leaf, and plug-in hybrids (PHEVs), such as the Chevrolet Volt, but excludes hybrid electrics (HEVs) that cannot be plugged and recharged from an off-vehicle electric energy source (U.S. EIA 2018). The United States is also the location of Tesla Motors, which has been the world's leading carmaker devoted to making and selling only electric vehicles. Nonetheless, in 2017, plug-in electrics accounted for only 1.2 percent of U.S. vehicle sales and 0.2 percent of vehicles of the U.S. vehicle stock ("Monthly Plug-in Sales Scorecard" 2018; Vaughan 2017). In 2016, China passed the United States as the

country with the largest number of electric vehicles on the road (Hertzke et al. 2017).

Most efforts by U.S. carmakers to increase fuel economy have been directed at improving conventional internal combustion engines. The most common alternative fuel vehicles are ethanol-powered and HEVs. In 2017, 8 percent of U.S. vehicles were ethanol-powered and 2 percent were HEV, according to the U.S. Department of Energy's Energy Information Agency (EIA) (U.S. EIA 2018).

Several carmakers are banking on hydrogen fuel cells rather than lithium-ion batteries to provide electricity for vehicles in the future. Honda, for example, expects to meet regulatory standards by electrifying two-thirds of its U.S. vehicles by 2030, with electricity to be generated primarily through fuel cells (Undercoffler 2016: 33).

The number of plug-in EV models available in the market was expected to increase from 49 in 2017 to 258 by 2025, according to London-based information provider (IHS) Markit (Karkaria 2018). Still, the EIA forecasts that in 2050, only 8 percent of U.S. vehicles will be plug-in electrics (U.S. EIA 2018). Low petroleum prices have kept consumer interest modest; it would probably take a sustained increase in fuel prices for PEVs and PHEVs to capture significantly higher market shares in the United States. One factor that will likely shape the pace of electrification in the U.S. vehicle market is government regulation regarding vehicle fuel economy (see section four of this paper).

Autonomy

The Society of Automotive Engineers (SAE), which is based in the United States, distinguishes six levels of autonomous vehicles, ranging from Level 0 (no automation) to Level 5 (full automation with no driver controls). Technology permitting Level 1 autonomy, such as cruise control, has long been standard in U.S. vehicles, as in the rest of the world, and Level 2 technology, such as automated emergency braking, has been added at a rapid pace to vehicles produced and sold in the United States.

The "legacy" carmakers, including Ford and General Motors (GM) (the two with U.S. headquarters), have added Level 2 autonomy in order

to make driver-operated vehicles safer, thereby reducing the number of accidents and fatalities. Vehicle-to-vehicle and vehicle-to-infrastructure communications are designed to intervene when a vehicle is in danger of hitting something, drifting out of a lane, or otherwise endangers the driver and passengers. The approach is being called a "war on traffic deaths" (Guilford 2016: 52). Secondary benefits of partial autonomy include finding parking places, maneuvering in tight spots, and avoiding traffic jams. Carmakers are prioritizing driver assistance based on affordability and consumer acceptance (Sedgwick 2016). To achieve higher levels of autonomy, Ford and GM have acquired tech companies. GM bought self-driving start-up Cruise Automation in 2016, and Ford bought artificial intelligence company Argo AI in 2018 (Walker 2018). Driverless vehicles may be especially attractive in the emerging sharing economy (see below); GM has acquired a stake in the carsharing company Lyft. In addition, autonomous class 8 trucks are expected by the mid-2020s (Sedgwick 2016).

Meanwhile, U.S. technology companies based in Silicon Valley Apple and Waymo (a subsidiary of Alphabet, formerly Google) have taken a different approach in trying to develop highly autonomous Level 4 and fully autonomous Level 5 driverless vehicles. Eschewing the continuous marginal improvement approach to autonomy embraced by the "legacy" carmakers, the tech upstarts have been testing fully autonomous technology in production vehicles of established carmakers. Waymo's business model intends to "build the world's most experienced driver" by way of artificial intelligence.

The two tech companies, as well as GM, have been the early leaders in testing Level 4 and Level 5 vehicles on the streets of several urban areas. Most U.S. states have enacted or at least considered legislation to legalize autonomous vehicles. At the national level, the National Highway and Transportation Safety Administration (NHTSA) has released several sets of guidelines for automated driving systems.

Formidable short- and medium-term obstacles hinder the operation of driverless vehicles on U.S. roads. Even if introduced in large numbers, driverless vehicles would have to share the road with drivers for many decades. Ultimately, consumer acceptance is likely to be the most critical factor in the pace of the introduction of fully autonomous vehicles.

Sharing

Two approaches to the sharing economy have become important for the U.S. auto industry: carsharing and ridesharing.

- Carsharing is the short-term rental of a vehicle, typically by the hour. Zipcar, a subsidiary of Avis Budget Group, is by far the leading carsharing company based in the United States.[3] It is differentiated from longer-term rental car services that have existed for more than a century. Carsharing is especially attractive for younger people ("millennials") living in urban neighborhoods who don't own a car because they rarely need one.
- Ridesharing connects an individual who needs a ride with a driver who has a car and is willing, for a fee, to take passengers to their desired destination. The United States is home to two of the leading ridesharing companies—Uber and Lyft. These two companies consider themselves to be providers of online transportation network services rather than transportation services. Their business is based on a mobile app, which allows an individual to submit a trip request and to pay for it, and allows a driver to find riders. Ridesharing services have proved controversial in the United States, as elsewhere. Principal concerns are directed at insufficient insurance and screening of participants. "Legacy" services such as taxicab companies have criticized sharing services for alleged lack of oversight and training.

U.S. carmakers are monitoring the sharing economy closely. They are finding that millennials are postponing vehicle purchases, but not giving up vehicle ownership altogether. Starting a family is found to be the key trigger in the decision to purchase the first vehicle (Naughton 2014). GM has invested in Lyft in part to induce Lyft drivers to buy or lease GM vehicles (Colias 2016).

U.S. Sales

More vehicles were sold in the United States than in any other country every year through the twentieth century and into the first decade of the twenty-first century. Sales in China exceeded those in the United States beginning in 2009. In 2017, the United States accounted for just over 18 percent of the world's new vehicle sales (International Organization of Motor Vehicle Manufacturers 2018).

Annual sales of new vehicles in the United States first exceeded 100,000 in 1909, 1 million in 1916, 2 million in 1919, 3 million in 1924, 4 million in 1929, 5 million in 1949, 10 million in 1965, 15 million in 1985, and 17 million in 2000 (*The 100-Year Almanac* 1996). The upward long-term trend masks short-term cyclical variations, which are prominent as vehicles represent durable consumer goods, the purchase of which can be put off during hard economic times. Sales tend to increase with the introduction of popular new models and during economic expansions and decline during economic slowdowns. Annual percentage increases and decreases in sales in excess of 20 percent are common in this industry.

Between 1984 and 2007, the United States witnessed much lower annual percentage changes in new vehicle sales. During that period, sales of light vehicles (i.e. cars and light trucks) averaged around 15 million, ranging between 12.3 million in 1991 and 17.3 million in 2000. The severe recession of 2008–09 was especially disruptive, when after a quarter-century of stability, sales plummeted to 10.4 million in 2009. Sales then increased steadily every year thereafter, until reaching an historic high of 17.4 million vehicles in 2015, declining somewhat since to 17.1 million in 2017 (WardsAuto Infobank).

Market Share

The U.S. market is highly competitive. Seven companies held between 7 percent and 18 percent of the market in 2017. The two carmakers with U.S. headquarters held the top two spots, General Motors (GM) with

17.5 percent of the market and Ford with 14.7 percent (Fig. 2.1). They were followed by Toyota with 14.2 percent, Fiat Chrysler (FCA) with 11.9 percent, Honda and Nissan with 9.6 and 9.3 percent, respectively, and Hyundai/Kia with 7.4 percent. Europe-based carmakers (other than FCA) had 8 percent of the market, and other, mostly Asia-based, carmakers had 7.5 percent (WardsAuto Infobank).

Automotive News identified around 100 companies with annual sales of at least 1000 vehicles during the first two decades of the twentieth century. However, the leading carmakers in the United States have remained remarkably stable through the entire century and a quarter of commercial production. Either Ford Motor Company or General Motors (including companies acquired by GM) has been the top-selling company in the United States every year since 1903 (*The 100-Year Almanac* 1996). Furthermore, throughout the twentieth century, either Ford or GM was also the world's best-selling company. Ford was the leader during the first quarter-century. GM first passed Ford in 1927 and was the world's leading seller through the remainder of the twentieth century. During the

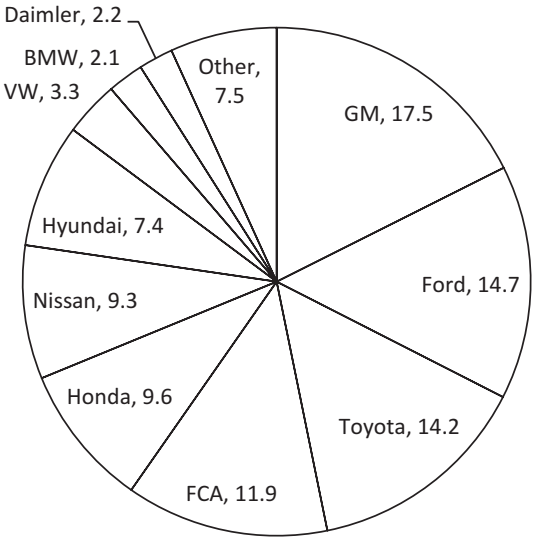

Fig. 2.1 U.S. light vehicle market share, 2017. Source: WardsAuto Infobank

first eighteen years of the twenty-first century, GM has shared the top three positions with Toyota and VW. Ford has generally fallen to the sixth place.

Ford Motor Company—Henry Ford's third attempt at establishing an automobile company—was incorporated in 1903 and passed Cadillac as the leading producer in 1906. Ford remained the leading producer every year until 1927. It averaged around 45 percent of sales during the 1910s and 1920s, and in its peak year of 1921, it accounted for 61 percent of all U.S. sales (*The 100-Year Almanac* 1996).

William C. Durant incorporated General Motors in 1908 as a consolidation of several existing carmakers, including Oldsmobile (the top-selling company in 1903 and 1904), Cadillac (the top seller in 1905), and Buick (the top seller in 1909). Durant was forced out of GM in 1910, incorporated Republic Motors in 1911, acquired Chevrolet in 1912, regained control of GM in 1916, and consolidated Chevrolet and other Republic holdings into GM in 1918 (Rubenstein 1992). GM supplanted Ford as the top-selling carmaker in the United States in 1927 and 1928, was second to Ford in 1929 and 1930, returned to the top in 1931, and has remained there every year since.

Walter P. Chrysler, a former GM executive, founded Chrysler in 1924 through the reorganization of Maxwell and acquired Dodge two years later. Chrysler prospered during the 1930s and passed Ford into second place in U.S. sales in 1936, 1938–41, and 1946 [no civilian production or sales occurred during World War II, 1942–45]. Ford returned to second place behind GM in 1947 and has held it every year since then. Chrysler was in third place every year from 1947 until it was passed by Toyota in 2006.

The 1929 stock market crash and subsequent Great Depression sealed the long-term dominance of the Detroit 3 carmakers. The combined market share of the three increased from 64 percent in 1927 to 90 percent in 1933 (*The 100-Year Almanac* 1996).[4]

At their peak of dominance in the 1950s, the Detroit 3 held as much as 95 percent of the U.S. market. The Detroit 3 market share declined to 84 percent in 1960, 83 percent in 1970, 74 percent in 1980, 72 percent in 1990, 64 percent in 2000, and 45 percent in 2010 (Automotive News Data Center). In 1960, the remaining 16 percent was divided among American Motors (AMC) with 6 percent, Studebaker-Packard and VW

with 2 percent each, other European imports with 5 percent, and other U.S. companies with 1 percent.

Over the years, the industry became increasingly international, going back to the mid-1950s, when the VW Beetle became the first vehicle model imported to the United States in large numbers. In 1980, most of the 26 percent market share not held by the Detroit 3 went to Japan-based companies including Toyota and Nissan, with 6 percent each, and Honda and other Japan-based companies, with 3 percent each. VW had 3 percent of the U.S. market in 1980, and AMC and other Europe-based companies had 2 percent each.

Asia-based companies have made further inroads into the U.S. market during the twenty-first century. Between 2000 and 2017, Toyota increased its share of the U.S. market from 9 to 14 percent, Honda from 6 to 10 percent, Nissan from 4 to 9 percent, and Hyundai from 2 to 7 percent. Toyota passed Chrysler in the third place in 2006.

Product Segments

The U.S. market is distinctive among the world's major markets because of the high share of trucks rather than cars. Vehicles classified as light trucks accounted for 64.5 percent of U.S. light vehicle sales in 2017. Trucks had previously accounted for 10 percent of U.S. light vehicle sales in the 1920s, 15 percent in the 1930s, 10 percent in the 1950s, 15 percent in the 1960s, 20 percent in the 1970s, 30 percent in the 1980s, and 40 percent in the 1990s. Trucks first outsold cars in 2002 and have accounted for more than one-half of sales nearly every year since then.

Light trucks sold in the United States can be grouped into four categories: crossover utility vehicles (CUVs), pickups, sport utility vehicles (SUVs), and vans. The two best-selling models in the United States most years have been the full-size pickup trucks sold by Ford and GM. However, as a group, CUVs accounted for the largest share of U.S. sales, 34.9 percent in 2017, compared with 16.1 percent for pickups, 8.1 percent for SUVs, and 5.4 percent for vans (WardsAuto Infobank).

A CUV is built on a car platform while incorporating features of a truck-like SUV, such as high ground clearance and large interior space.

The segment incorporates a variety of individual products ranging widely in price, size, and degree of luxury. Classifying a vehicle as a truck rather than a car has been important for U.S. carmakers because for several decades trucks had been subject to less stringent fuel economy standards.

The two leading car segments are midsize and compact; they accounted for 12.8 percent and 12.4 percent of the total U.S. light vehicle sales in 2017, respectively. Luxury cars accounted for 6.1 percent of sales, subcompacts for 2.8 percent, and large cars for 1.5 percent (Fig. 2.2).

U.S. Production

Annual light vehicle production in the United States first exceeded 100,000 in 1909, 1 million in 1916, 2 million in 1919, 3 million in 1924, and 4 million in 1929. Following an extended period of limited production during the Great Depression and World War II, U.S.

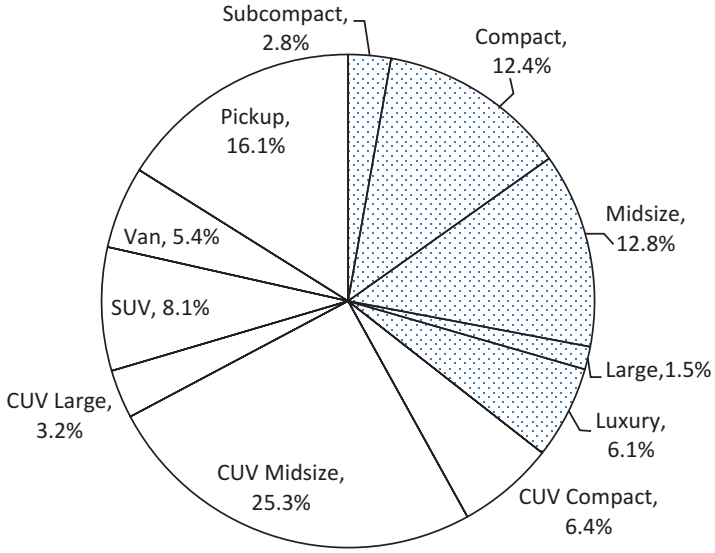

Fig. 2.2 U.S. light vehicle market segments, 2017. Source: WardsAuto Infobank

production exceeded 5 million in 1949, 8 million in 1950, 9 million in 1955, and 11 million in 1965.

The United States dominated the global production of vehicles during the first half of the twentieth century. As recently as 1950, 76 percent of the world's vehicles were produced in the United States. The U.S. share has dropped steadily since then to 70 percent of the world production in 1955, 48 percent in 1960, 28 percent in 1970, and 21 percent in 1980. In 2017, 18 percent of the world's vehicles were produced in the United States. More vehicles were produced in Japan than in the United States between 1980 and 1993 and between 2006 and 2010. In 2009, China passed both Japan and the United States to become the leading producer. The United States has become a distant second in production to China since 2011 (*The 100-Year Almanac* 1996).

Since the mid-1960s, U.S. production has averaged around 11 million light vehicles per year. In the 36 years between 1971 and 2007, annual production came to between 10 million and 12 million units 21 times, dipped below 10 million units 6 times, and exceeded 12 million units 9 times. As a result of this long-term stability, the severe recession of 2008–09 came as an especially sharp blow to the U.S. auto industry. Production declined to 5.8 million in 2009, the lowest level since 1958. Production returned to the long-term average of 11 million in 2013, averaging 11.5 million in the four years from 2014 through 2017 (WardsAuto Infobank).

Starting in the late 1970s, foreign-headquartered producers entered the U.S. market as producers (Table 2.1). VW was first; it started producing vehicles at a former Chrysler plant in Westmoreland, Pennsylvania, in 1978. Honda, the first of the Asian-based producers, arrived in 1982. The two German premium brand producers BMW and Mercedes opened their first plants in the 1990s; Korean producer Hyundai arrived in the first decade of the twenty-first century. In 2017, 12 carmakers produced at least 100,000 light vehicles in the United States. The share of U.S. production accounted for by the Detroit 3 carmakers declined from 87 percent in 1990 to 78 percent in 2000, 55 percent in 2010, and 52 percent in 2017.

Table 2.1 Foreign-headquartered light vehicle producers in the United States by year of the first assembly plant

VW[a]	1978
Honda	1982
Nissan	1983
Toyota	1984
Mitsubishi[b]	1987
Mazda[c]	1987
Subaru	1989
BMW	1994
Mercedes-Benz	1997
Hyundai/Kia	2005

[a]Closed in 1989, the new plant opened in 2011
[b]Closed in 2015
[c]Ended U.S. production in 2012, the new plant opened in Mexico in 2013. U.S. plant continues as Ford plant

Geography of Production

The U.S. auto industry is highly clustered in an area known as auto alley, a north-south corridor between Michigan and Alabama, roughly 800 miles long and 250 miles wide. The spine of the auto alley is formed by the north-south interstate highways I-65 and I-75 (Klier and Rubenstein 2008; Klier and McMillen 2006, 2008; and Rubenstein 1992). Within the United States, auto alley accounted for 85 percent of light vehicle production in 2017 (authors' calculations based on data from WardsAuto Infobank).

In 2018, the United States had 43 assembly plants that could produce at least 100,000 vehicles per year. General Motors operated 11 of them; Ford 9; FCA 6; Honda and Toyota 4 each; Hyundai and Nissan 2 each; and BMW, Daimler, Subaru, Tesla, and VW 1 each. All but 6 of the 43 were in the auto alley. Of the 37 in the auto alley, 11 were in Michigan; 6 in Ohio; 4 in Indiana; 3 each in Alabama, Kentucky, and Tennessee; 2 each in Illinois and Mississippi; and 1 each in Georgia, Missouri, and South Carolina. The six outside auto alley included 2 each in Missouri and Texas and 1 each in California and Kansas (Fig. 2.3).

The auto alley is divided along the east-west route U.S. 30 into northern and southern sections. Eighteen of the 37 assembly plants in the auto

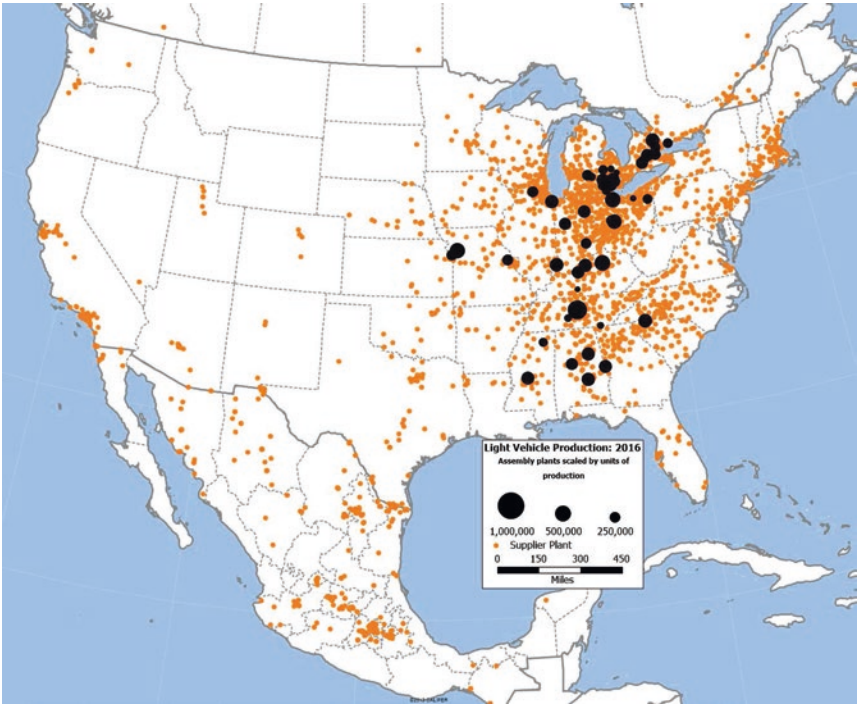

Fig. 2.3 Light vehicle assembly plants and parts supplier plants in North America, 2016. Source: Authors' adaptation of data from Wards Autoinfobank, Elm, and Maptitude

alley are in the northern section and 19 in the south of U.S. 30. All 18 of the northern assembly plants are owned by the Detroit 3 carmakers, whereas 15 of the 19 southern assembly plants are operated by foreign-based carmakers.

The north-south division within the auto alley is related to rates of unionization. The United Auto Workers union represents workers in all of the assembly plants owned by the Detroit 3 but in none of the assembly plants owned by other carmakers. International carmakers have selected assembly plant sites in the southern portion of an auto alley in part to avoid the northern area that has historically been associated with relatively high rates of unionization in the auto industry (Fig. 2.4).

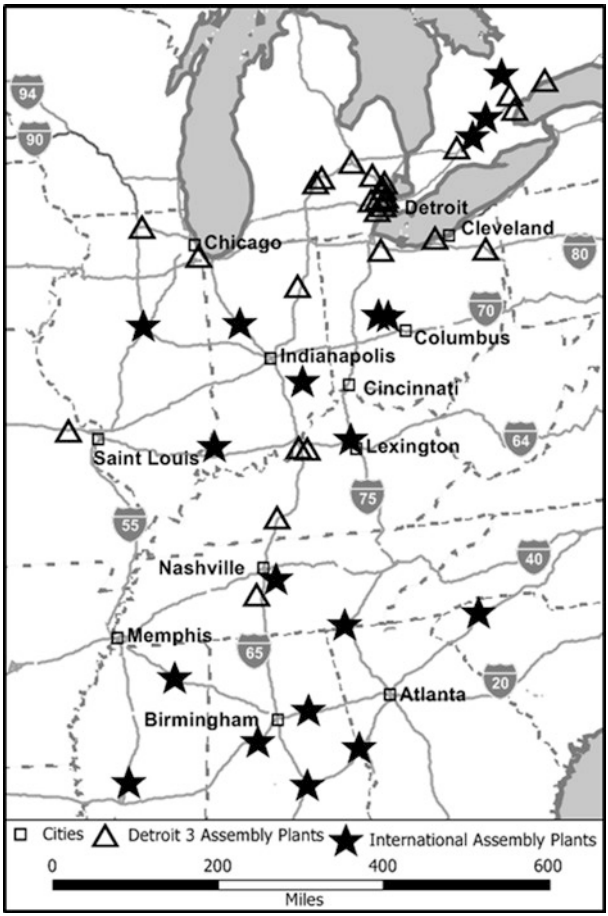

Fig. 2.4 Light vehicle assembly plants by nationality, 2016. Source: Authors' adaptation of data from Wards Autoinfobank, Elm, and Maptitude

Parts Suppliers

Most parts used to assemble vehicles in the United States are made in North America. Employment in the production of motor vehicle parts represents about three-quarters of overall industry employment (see Klier and Rubenstein 2008, for a comprehensive treatment of that part of the industry). The industry geography is characterized by pronounced co-location of vehicle assembly and vehicle parts production (see Fig. 2.3).

According to *Automotive News*, 11 suppliers had North American sales exceeding $5 billion in 2017: Magna International, ZF, Denso International, Continental Automotive Systems, Lear, Robert Bosch, Flex-N-Gate, Aisin World, Adient, American Axle & Manufacturing, and Hyundai Mobis. Only two of the ten largest suppliers in 2017 were among the ten largest in 1994: Lear and Adient (spun off from Johnson Controls in 2016). Only five were among the top ten in 2004: Adient, Lear, Magna International, Robert Bosch Corp., and Denso International (known as Nippondenso until 1996).

Only four of the ten largest suppliers in 2017 were based in the United States; three were headquartered in Germany, two in Japan, and one in Canada. By comparison, all ten of the leading suppliers in 1994 and six of the ten in 2004 were U.S. companies (two were German and one each Canadian and Japanese in 2004) (Table 2.2).

Trade

With U.S. sales averaging 15 million light vehicles per year and production averaging 11 million, the gap is being covered through imports. These imports may be originating from elsewhere in North America (i.e.

Table 2.2 Top auto parts suppliers in North America, 1994, 2004, and 2017

1994	2004	2017
GM ACG (Delphi)	Delphi	Magna International
Ford ACD (Visteon)	Visteon	ZF North America
Delco Electronics	Magna International	Denso International America
Inland Steel	Johnson Controls	Continental Automotive Systems
Dana Corp.	Lear Corp.	Lear
TRW Inc.	Robert Bosch Corp.	Robert Bosch
Lear (Seating) Corp.	Dana Corp.	Flex-N-Gate
Johnson Controls	Nippondenso	Aisin World
DuPont Automotive	TRW Inc.	Adient
ITT Automotive	ThyssenKrupp Automotive	American Axle & Manufacturing

Source: Automotive News Supplement, various years

Canada and Mexico) or from other regions of the world (Asia and Europe). The North American Free Trade Agreement (NAFTA) as originally negotiated permitted light vehicles to be shipped tariff-free within North America as long as their North American content was at least 62.5 percent (for vehicle parts, the requirement was at least 60 percent).[5] Light vehicles imported to the United States from elsewhere in the world have been subject to the World Trade Organization (WTO) tariff of 2.5 percent with the exception of pickup trucks and cargo vans, which have faced a tariff of 25 percent (the so-called chicken tax, which goes back to a trade dispute between Germany/France and the United States in 1964; see e.g. Hoffman 2018).

Imports first appeared in the United States in significant numbers in the late 1950s. Imports from outside of North America accounted for 7 percent of U.S. sales in 1960, 13 percent in 1970, and 24 percent in 1980. The figure declined to 22 percent in 1990, primarily because of the construction of assembly plants in North America by several Asian carmakers during the 1980s. Voluntary export restraints adhered to by Japanese carmakers also contributed to the decline during the 1980s.

In 2014,[6] 11.4 million vehicles were produced in the United States; 9.0 million of these vehicles were sold in the United States and 2.4 million were exported, including 1 million to Canada, 247,000 to Mexico, and 1.2 million to the rest of the world. U.S. sales amounted to 16.5 million in 2014; 9.0 million of these sales were vehicles produced in the United States, 1.7 million were imported from Mexico, 1.9 million were imported from Canada, and 3.9 million were imported from elsewhere in the world. Figure 2.5 displays the flow of vehicles in the United States from production to sales in 2014.

Otherwise stated in 2014, 55 percent of the vehicles sold in the United States were produced in the United States, 10 percent were imported from Mexico, 12 percent were imported from Canada, and 24 percent were imported from elsewhere in the world. Meanwhile, 79 percent of the vehicles produced in the United States in 2014 were sold in the United States, 9 percent were exported to Canada, 2 percent were exported to Mexico, and 11 percent were exported to the rest of the world (see Fig. 2.5).

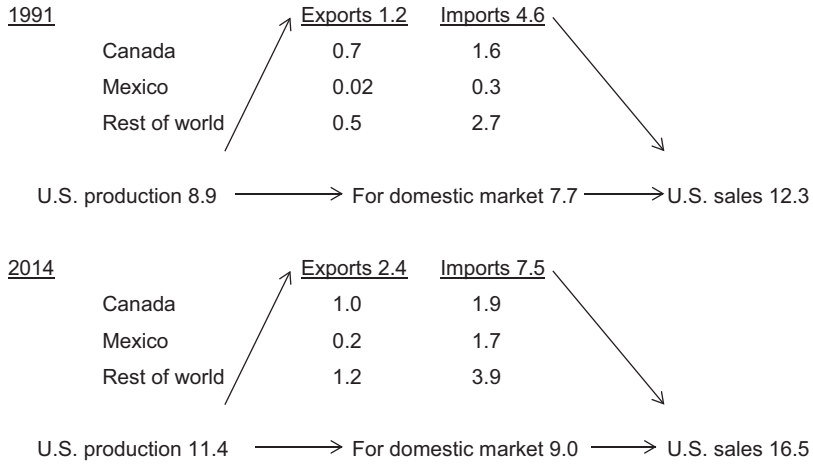

Fig. 2.5 U.S. production, sales, and trade flows, 1991 and 2014. Sources: Estimated by authors from IHS Markit and Automotive News Data Center

In comparison, in 1991, approximately 63 percent of the 12.3 million vehicles sold in the United States were produced in the United States, 13 percent were imported from Canada, 2 percent were imported from Mexico, and 22 percent are imported from elsewhere in the world. Approximately 87 percent of the 8.9 million vehicles produced in the United States were sold in the United States, 8 percent were exported to Canada, and 6 percent were exported to the rest of the world (exports to Mexico accounted for only 0.2 percent of U.S. production in 1991).

Thus, the overall role of trade in U.S. production and sales has changed during the past several decades, primarily through an increase in the share of imports from Mexico from 2 percent to 10 percent of U.S. sales. Sales of light vehicles in the United States were approximately 4 million higher in 2014 than in 1991; U.S. production accounted for around 2.5 million of the growth of 4 million units and net imports from Mexico for most of the remaining 1.5 million units.

Nearly all of the early imports were small cars from Europe. European carmakers accounted for 64 percent of imports into the 1970s. Renault was the leading importer into the United States in 1959, and VW was the leading importer between 1960 and 1974. Japan rapidly replaced Europe

as the principal source of imports into the United States during the late 1970s. Japanese carmakers comprised 77 percent of imports in 1980 and 85 percent in 1990; Toyota had passed VW as the leading importer in 1975.

Today, reliance on imports into the United States varies by the nationality of the carmaker. Japan-based carmakers imported from Japan 25 percent of the vehicles they sold in the United States in 2017. Conversely, in 2017, Europe-based carmakers imported 59 percent of their U.S. sales from Europe, and Korea-based carmakers imported 48 percent of their U.S. sales from Korea. U.S.-based carmakers produced 95 percent of their U.S. sales in North America.

The U.S. auto industry is closely integrated with the auto industries of its neighboring countries Canada and Mexico. In 2014, the United States exported 1 million vehicles to Canada and imported 1.9 million from there. The United States exported 247,000 vehicles to Mexico and imported 1.7 million from its neighbor to the south.

The U.S. and Canadian motor vehicle industries became highly integrated during the 1960s (Anastakis 2005). Prior to that time, high tariffs limited the movement of vehicles and parts between the United States and Canada. To serve the relatively small Canadian market, assembly plants in Canada had to produce small batches of a wide variety of models, an inefficient arrangement. The elimination of trade barriers induced U.S.-owned carmakers and parts suppliers to view the United States and Canada as a single area for the production of vehicles and parts. Subsequently, vehicles produced in Canada increased from approximately 0.1 percent of U.S. sales in 1963, 2 percent in 1966, and 5 percent in 1969. Canada exported 4 percent of its vehicle production to the United States in 1963, 45 percent in 1966, and 72 percent in 1969. In the other direction, 4 percent of vehicles produced in the United States were sold in Canada in 1963, 6 percent in 1966, and 12 percent in 1969. Vehicles produced in the United States accounted for 57 percent of vehicles sold in Canada in 1963, 71 percent in 1966, and 85 percent in 1969 (Holmes 1983 in Rubenstein 1992: 226).

Mexico started becoming integrated into the North American auto industry geography through a series of automotive decrees during the 1970s and 1980s. The implementation of NAFTA in 1994 removed most of Mexico's lingering trade restrictions (Brincks et al. 2018: 9). A

number of provisions of the NAFTA agreement were phased in over its first ten years. In light of the uncertainty over the future of NAFTA following the election of Donald Trump as U.S. President in 2016, several vehicle producers made changes to their product planning for North America: Ford canceled a new assembly plant to be built in Mexico (Naughton 2017), FiatChrysler decided to move production of its full-size pickups from Mexico to the United States (Dawson and Stoll 2018), and Toyota shifted the production of its Corolla from a plant under construction in Mexico to a plant being built in the United States (Iliff 2018).

According to the U.S. Department of Commerce International Trade Administration Office of Transportation and Machinery, the United States imported $143 billion worth of parts in 2017, including $53 billion from Mexico, $17 billion from China, $16 billion from Canada, $15 billion from Japan, $10 billion from Germany, $9 billion from the rest of Europe, $8 billion from South Korea, and $15 billion from the rest of the world. The United States exported $86 billion worth of parts in 2017, including $31 billion to Canada, $30 billion to Mexico, $8 billion to Europe, and $17 billion to the rest of the world (U.S. Department of Commerce 2018).

Government Role

The U.S. government has played an increasingly important role in regulating the motor vehicle industry. Regulation has been especially important in three areas: emissions, fuel economy, and safety.

The federal initiative to control pollutants initiated with the 1970 Clean Air Act, which called for the U.S. Environmental Protection Agency (EPA) to issue national air quality standards and specify required emission reductions. A year later, the EPA called for 90 percent cuts in emissions for carbon monoxide and hydrocarbons by 1975 and for nitrogen oxides by 1976. Goals were later pushed back to 1981. Carmakers met the standards primarily by introducing catalytic converters in newly produced cars. Nitrogen oxide and hydrocarbon emissions in the United States declined by more than 95 percent between 1970 and 2000, and carbon monoxide emissions decreased by more than 75 percent (Rechtin 1993: 152, in Rubenstein 2001: 245–246).

The first U.S. legislation designed to conserve petroleum was the 1975 Energy Policy and Conservation Act. All manufacturers selling more than 10,000 cars a year in the United States had to meet the corporate average fuel economy (CAFE) standard set by the U.S. Department of Transportation. The first CAFE standard, issued in 1975, required manufacturers to achieve a fleet average for passenger cars of 18 miles per gallon (mpg) in 1978, 20 mpg in 1980, and 27.5 mpg in 1985. Separate CAFE standards were set for trucks (Korylko 1996: 136, in Rubenstein 2001: 242). The Energy Independence and Security Act of 2007 set targets of 30.2 mpg for cars and 24.1 mpg for light trucks in 2011. A 2011 agreement among President Barack Obama, 13 carmakers, the United Auto Workers union, and the State of California set overall targets for light vehicles of 37 mpg in 2021 and 54.5 mpg in 2025 (Klier and Linn 2011, 2016).[7] Future fuel efficiency standards were thrown into uncertainty in 2018 when the Trump Administration proposed freezing CAFE at the 2021 level of 37 mpg, whereas the State of California called for honoring the 2011 agreement to achieve 54.5 mpg in 2025.

Federal regulation of vehicle safety can be traced to the National Traffic and Motor Vehicle Safety Act and the Highway Safety Act, both enacted in 1966. The National Highway Safety Bureau (since 1970, the National Highway Traffic Safety Administration) was empowered to set standards for automotive safety and order recalls of vehicles with safety-related defects. One of NHTSA's first initiatives, under the 1972 Motor Vehicle Information and Cost Saving Act, set and enforced standards for bumpers to withstand low-speed accidents.

Aside from legislative and regulatory updates for emissions, fuel economy, and safety, the most important federal involvement in the U.S. auto industry came during the severe recession of 2008–09. Faced with the prospect of General Motors and Chrysler running out of money in the final weeks of his presidency, President George W. Bush in December 2008 issued an executive order authorizing emergency loans to be made to the two carmakers under the Troubled Asset Relief Program (TARP). Shortly after taking office, President Barack Obama established an Auto Industry Task Force in February 2009 to deal with the financial crisis. After finding that the companies' plans for restoring financial solvency

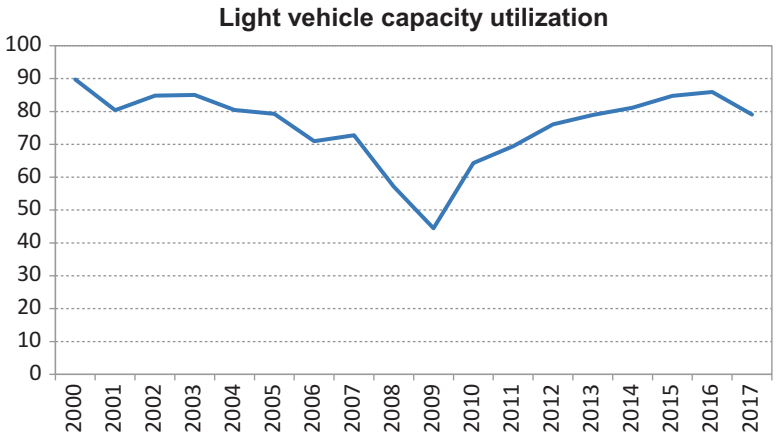

Fig. 2.6 Capacity utilization for the U.S. auto industry, 2000–17. Source: Federal Reserve Board, Haver Analytics

were inadequate, the Task Force managed the restructuring of GM and Chrysler in 2009 under the U.S. Bankruptcy Code. The U.S. government held shares in the restructured Chrysler until 2011 and in the restructured GM until 2013 (Klier and Rubenstein 2013).

During the severe recession and restructuring period, 15 U.S. assembly plants were closed. As a result, the capacity utilization of U.S. assembly plants—a key indicator of the health of the industry—rose from 44 percent in 2009 to 79 percent in 2017 (Fig. 2.6).

Future Prospects

Long-term prospects remain strong for both the sales and production of vehicles in the United States as the country remains a large and wealthy market for vehicles, and the nation's relatively low density and dispersed population distribution point to continued dependence on vehicles for transportation. Yet the vehicle industry is experiencing significant change at many levels. Below are our suggestions regarding the way the three disruptions discussed at the beginning of the chapter might impact the structure of the industry in the United States.

Vehicles represent the textbook case of a weight-gaining good. Motor vehicle production remains a highly agglomerated industry, and assembly plants are situated to minimize the costs of shipping finished vehicles to dealerships (Klier and Rubenstein 2011, 2012, 2015). Neither a move from vehicles powered by internal combustion engines to those powered by electricity nor increased usage of autonomous vehicles seems to change the robustness of this industry characteristic: most vehicles sold in the United States are expected to be built in the United States.

To the extent that changes to trade agreements introduce sharp barriers to trade, one would expect a re-optimization of the footprint of production of the vehicles and parts to the extent it involves different countries.

Finally, to the extent that the new technology, for example electric motors and related capabilities as well as software engineering related to autonomous vehicles, commonly referred to as AI, draws on centers of excellence that are not part of the current automotive R&D cluster in southeast Michigan (see e.g. Klier et al. 2014), one has to wonder if R&D activities in this industry going forward will continue to take place in a highly spatially concentrated fashion or if they will be separable along particular core technologies.

Notes

1. For a critical view on some of the changes, see Gladwell (2017).
2. "Compared with car design's advanced calculus of millions of simultaneous complex equations, the iPad's design is basic arithmetic" (MacDuffie and Fujimoto 2010).
3. The world's leading carsharing company cargo is not a major player in the U.S. market as of 2018.
4. Between 1927 and 1933, GM's market share increased from 42 percent to 44 percent, Ford's from 17 percent to 22 percent, and Chrysler's from 5 percent to 24 percent.
5. See Canis et al. (2017). Note that these requirements are specified in the original NAFTA treaty and are currently being re-negotiated.

6. We have data that link the country of production to the country of sale for North American production; that data ends in 2014.
7. Compliance with the 54.5 mpg target is based on laboratory tests conducted by the U.S. Environmental Protection Agency.

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