

The Electric Vehicle Revolution: A New Track for Industrial Competition among Major Countries

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Abstract: The automobile industry is a pillar industry of the national economy, because it is closely related to many industries and contributes to the development of other industries, and it has always been an area of strategic importance for industrial competition among major countries. Since the start of the Industrial Revolution, countries such as the United States, Germany, Japan and the Republic of Korea have successfully established their status as major automobile powers through technological innovation and capacity expansion, which has also contributed to their emergence as global industrial powers in different periods. The new technological route brought about by the electric vehicle revolution is reshaping the competition landscape of the global automobile industry and providing an important “window of opportunity” for latecomer countries to catch up. To compete on this new “track” for the electric vehicle industry, major economies have been cultivating a favorable environment for the development of electric vehicle industry chains through domestic industrial policies and international economic diplomacy. Faced with the rare opportunity to overtake other countries in the automobile industry and the increasingly fierce international competition, China needs to make efforts in both domestic affairs and diplomacy fronts to gain a leading position in electric vehicle manufacturing and help China fulfill its “dream of becoming a powerful country” for China’s automobile industry.

Keywords: Electric Vehicle, Supply Chain Security, Industrial Policy, Industrial Competition among Major Countries, Strategic Industry

Since the Industrial Revolution, automobile manufacturing has been known as “the industry of industries” for its wide coverage of industrial chain and has

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been considered as a pivotal industry closely related to the competition among major countries. A potent automobile industry not only represents advanced industrial technology and manufacturing capacity, but also plays a significant role in driving national economic growth because of its deep connection with the upstream and downstream industries. It is indeed the national strategic industry. After over a century dominance of fuel-powered vehicles in transport equipment, the global advocacy for “decarbonization” facilitates the application and promotion of electric vehicle (EV). The electrification revolution of transport equipment is unstoppable. The brand-new technological route creates a “new track” for industrial competition among major countries, thus opening the “window of opportunity” for the latecomer countries to catch up. Gaining the upper hand in the competition in the EV industry is of strategic importance to the economic development of a country, especially the establishment of its status as an industrial power, as well as the energy conservation and emission reduction and energy security.

I. INTERNATIONAL MIGRATION OF THE AUTOMOBILE INDUSTRY AND INDUSTRIAL COMPETITION AMONG MAJOR COUNTRIES

Automobile manufacturing is crucial to the development of national economy. It is a pivotal industry that makes a country an industrial power and the strategic industry relating to the competition among major countries. First of all, as one of the largest industries in the national economy, the automobile industry contributes to a considerable share of economic growth and generates a great many jobs, maintaining economic and social stability. According to statistics, the automobile industry created nearly 3% of the global GDP¹ and had a higher employment multiplier.² In addition, the automobile industry also radiates to

1 Geotz Klink et al., The Contribution of the Automobile Industry to Technology and Value Creation, <https://www.middle-east.kearney.com/documents/291362523/291363965/The+Contribution+of+the+Automobile+Industry+to+Technology+and+Value+Creation.pdf/ad8ccb9a-212c-6bf8-35f8-4732a24ea2ce> (Last Visited on November 20, 2022).

2 Mitch Bainwol et al., The Auto Industry Is a Huge Job Creator, <https://rollcall.com/2015/01/29/the-auto-industry-is-a-huge-job-creator> (Last Visited on November 18, 2022).

the whole industrial system, including the upstream mineral raw materials exploitation, smelting and processing, midstream machinery manufacturing and assembly, and downstream financial and service industries. It boosts up the related industries and builds up the industrial capacity of a country. Last but not least, the automobile industry is an “incubator” for advanced technology. It not only represents the core achievements of the Second Industrial Revolution, but also keeps up with the market demand for intelligence and electrification. It has become an important scenario for the industrialization of emerging technologies.

A. Automobile Manufacturing: A Symbol of National Industrial Strength

As the automobile manufacturing industry is of strategic importance to national economy, the major industrial powers in the world have strong automobile industries. Since the birth of the automobile industry, the global automobile manufacturing center has shifted for several times, which has directly changed the situation of industrial competition among major countries. The global automobile industry undergoes roughly four development stages. The prototype of the automobile industry came into being in European countries during the Second Industrial Revolution. In the early 20th century, the United States (US) toppled European countries to become the world’s first automobile manufacturing center and established the global industrial hegemony. After World War II, Germany, Japan and the Republic of Korea entered the arena of automobile manufacturing in succession and became key forces in the global industrial system. China is rising and becomes an emerging automobile manufacturing center in the recent decade. It is likely to seize the opportunity of the EV revolution to upgrade from a major industrial country to an industrial power.

Propelled by the First Industrial Revolution, steam-driven vehicles were first made in France and then spread to the United Kingdom. After that, Germany and France developed internal combustion engine vehicles (ICEV) during the Second Industrial Revolution, forming a different technology

route from that of steam vehicles. The US did not stop chasing even when it was falling behind. In the late 19th century and early 20th century, American engineers represented by the Duryea brothers and Henry Ford developed gasoline-powered vehicles and gained international reputation.³ Many manufacturers were attracted to the industry, laying the foundations for the domestic automobile industry in the US.

The automobile industry grew rapidly from 1910s to 1950s. The US firmly established itself as the center of the global automobile industry during this period. Ford Motor Company introduced the “moving assembly line” to significantly improve efficiency and reduce costs in 1913. Other American automakers learned from Ford and realized scale production. During World War I, the war-related demand for automobile industry stimulated capacity expansion and technological advancement. The automobile industry in the US embraced best development opportunities under the peaceful domestic environment. It became the largest industrial sector in the US by the 1920s and the US was recognized as a global power. As shown in the Table 1, as of 1928, the proportion of US automobile exports soared from 25% before the World War I to 72% of the global automobile exports. The automobile parts manufacturing and assembly were basically completed within the territory of the US.⁴ The US automobile industry greatly promoted the production of steel, petroleum and other industrial sectors and created a large number of jobs directly or indirectly. By 1929, the total industrial output of the US accounted for 42% of the total global output, exceeding the sum of all European countries.⁵ Over three million people worked in the automobile industry during the same period.⁶ Moreover,

3 In 1895, the Chicago Times Herald sponsored a global automobile race, in which the car designed by the Duryea brothers and another Mercedes-Benz car won the first and the second prize respectively. The emerging automobile industry in the United States hence won international recognition and built more confidence into the domestic automobile industry in the United States.

4 Carl H. A. Dassbach, *The Social Organization of Production, Competitive Advantage and Foreign Investment: American Automobile Companies in the 1920s and Japanese Automobile Companies in the 1980s*, *Review of International Political Economy*, Vol. 1, No. 3, 1994, pp. 489–517.

5 Leften Stavros Stavrianos, *A Global History: From Prehistory to the 21st Century*, Shanghai Academy of Social Sciences Press, 1992, p. 614.

6 Frank P. Huddle, *Automobiles in the Postwar Economy*, *Editorial Research Reports 1945*, <http://library.cqpress.com/cqresearcher/cqresrre1945082100> (Last Visit on November 20, 2022).

the automobile industry fueled the emergence of large industrial cities. The Big Three — General Motors, Ford and Chrysler gathered in Detroit, attracting other supporting industrial sectors and talent resources, making it one of the major industrial cities in the US. The promotion of industrial production, employment and urbanization by the automobile industry contributed to the “Coolidge Prosperity” during this period. In contrast, European automakers were less responsive to the new production mode than the US and were badly stricken by the war, thus gradually falling behind the US in the competition. Since then, due to the impact of the Great Depression, the European automobile industry was no longer comparable to that of the US.

Table 1: Share in Global Automobile Exports by Country

Country	1907	1913	1923	1928
France	57%	33%	11%	6%
The United Kingdom	13%	16%	2%	5%
The United States	11%	25%	54%	72%
Germany	7%	16%	2%	1%

Data Source: *See supra* n. 4, Carl H. A. Dassbach (1994).

With the outbreak of the US-EU tariff war caused by the Great Depression in 1930s, American automakers took a strategy of “offshore manufacturing” and built production bases in the destination countries to evade tariffs and reduce transportation costs. They relied more on external suppliers for automobile parts in order to optimize the supplier portfolio and meet market demand more flexibly. Taking General Motors as an example, Figure 1 shows that the proportion of the offshore procurement of parts was increasing and exceeded domestic procurement from 1926 to 1938, which was a foreshadowing of the subsequent relative decline of the domestic automobile industry in the US.

There was a large-scale transfer of the global automobile industry from the 1950s to the early 21st century. During this period, the Germany emerged as a major player, followed by Japan and the Republic of Korea rising as strong forces in the international market in the 1970s and 1990s respectively. The

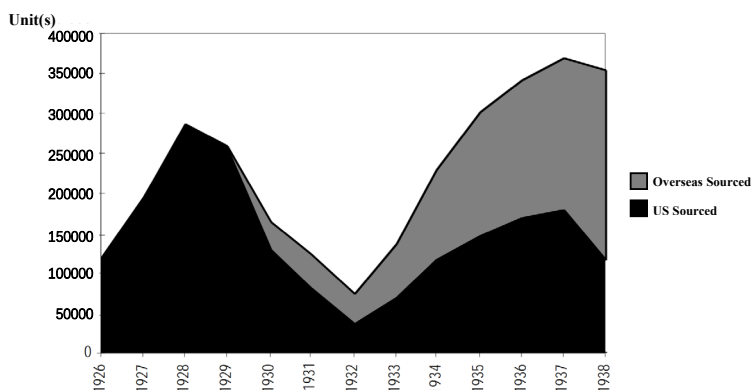


Figure 1: Share of Overseas Sourced and US Sourced Automobile Parts of General Motors (1926–1938)

Data Source: Timothy Sturgeon and Richard Florida, *Globalization and Jobs in the Automotive Industry*, MIT Industrial Performance Center, https://creativeclass.com/articles/2000-The_World_That_Changed_The_Machine_Globalization_And_Jobs_In_The_Automotive_Industry.pdf (Last Visited on November 20, 2022).

hegemony of the US in the automobile industry encountered severe challenges and was on the wane relatively. Multipolarity started to dominate the global automobile industry. Despite the heavy losses in the World War II, owing to the technology accumulation and solid industrial foundation, in the 1950s, Germany fully restored civilian industrial production with the support of the Marshall Plan, including automobile manufacturing. During this period, the cheap and cheerful Volkswagen Beetle became well accepted. German cars swept across the European market. Germany subsequently became the largest automobile producer and exporter in Europe, ascending to a great power in the automobile industry.⁷ Thereafter, German automakers made heavy investment in product research and development and production technology innovation to continuously meet market demand. German automobile industry has always maintained its core competitiveness and has long been the largest industrial

7 NES Fircroft, *A Brief History of German Automotive Engineering*, <https://www.nesfircroft.com/blog/2021/11/a-brief-history-of-german-automotive-engineering?source=google.com.hk> (Last Visited on November 20, 2022).

sector in Germany, accounting for 20% of the total industrial revenue and providing 12% of employment in Germany's manufacturing industry.⁸

Japan's automobile industry rose slightly later than that of Germany's, and its ability to catch up with the US mainly relies on the comparative advantage in the field of technology.⁹ After World War II, the Japanese government adopted the strategy of "using it for my own benefit" and proposed the Basic Countermeasures for the Automobile Industry in 1949 to restrict imports and encourage domestic production and technology introduction. Subsequently, the outbreak of the Korean War brought a surge of orders for military supplies of the US, which greatly stimulated the recovery of the automobile industry in Japan. The development of new technologies such as microelectronics and new materials in the 1960s led Japan onto a development path of technological differentiation. Japan integrated foreign manufacturing technologies to develop Japanese compact cars that were totally different from the large-displacement American cars and this type of car became very popular in the international market. Toyota, a Japanese automaker, rose to the third largest automaker in the world with its production increasing from 20,000 to 2 million vehicles from 1961 to 1971.¹⁰ With the sharp rise in oil price caused by the oil crisis in the 1970s, the small-displacement and cost-effective Japanese cars broke into the US market. Japan dethroned the US to become the world's largest automobile producer and exporter in 1980 and had remained at the top of the list for over ten years, which signaled a new chapter of Japan as a great power in global automobile manufacturing.¹¹

Following Germany and Japan, the Republic of Korea government formulated an automobile industry development plan in the 1960s and adopted a development method similar to that of Japan. In early stages of industrial

8 European Automobile Manufacturers Association (ACEA), The Automobile Industry Pocket Guide, <https://www.acea.auto/publication/automobile-industry-pocket-guide-2020-2021> (Last Visited on November 20, 2022).

9 Jean-Pierre Lehmann, France, Japan, Europe, and Industrial Competition: The Automotive Case, *International Affairs*, Vol. 68, No. 1, 1992, pp. 37-53.

10 Jie Bai, Yu Zhou and Shucen Liu, *Legend of Toyota*, China Machine Press, 2010, p. 3.

11 Hongtao Guan, Changes in Japan's Policy on Automobile Industry in the 21st Century and the Impacts, *Contemporary Economy of Japan*, Vol. 159, No. 3, 2008, pp. 54-59.

development, it mainly relied on joint ventures to accumulate experience for domestic automobile industry. Subsequently, the domestic substitution of parts was quickly completed through the “localization of automobile” in the 1970s. By the 1990s, the Republic of Korea’s automobile industry has shifted from domestic sales to exports. The Republic of Korea has become the world’s fourth largest automobile exporter and has set up independent research and development centers worldwide to build a global technology network.

In contrast, the automobile industry in the US has experienced a relative decline, which was demonstrated by the shrinkage of market share and hollowing out of local manufacturing. From the perspective of market share, Japanese cars greatly catered to the market demand in terms of model and design. In addition, traditional US automakers represented by General Motors were hard to compete with Japanese counterparts in costs. American automakers were hit badly by the significant loss of market share and the profit slump. As shown in Figure 2, the domestic market share of American automakers was nibbled by Japanese automakers since the 1970s. The local market share of the “Big Three” in the US declined from 85% to 44% from 1960 to 2010.¹²

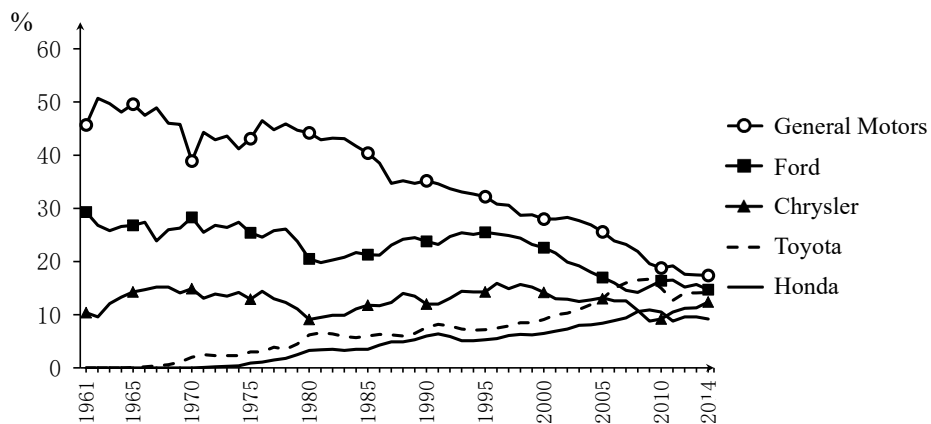


Figure 2: Market Share of Major American and Japanese Automakers in the United States (1961–2014)

Data Source: The author drew the line chart based on data from WardsAuto.

¹² Marcus Lu, The Decline of US Car Production, <https://www.visualcapitalist.com/the-decline-of-u-s-car-production> (Last Visited on November 20, 2022).

From the perspective of domestic manufacturing, the strategy of “offshore manufacturing” taken by the US in the early stage caused large-scale outflow of the domestic automobile industry chain. The ratification of the North American Free Trade Agreement (NAFTA) further sped up such outflow, directly affecting the automobile production. As we can see from Figure 3, the US was outperformed by Japan for the first time in the 1980s in terms of the annual domestic automobile production. As a result of the production outflow, mass unemployment occurred in Detroit and other cities that were highly dependent on the automobile industry. By the end of 2005, the resident population of Detroit dropped from a peak of 1.85 million to 890,000. The once prosperous “Motor City” has gradually coming down, indicating that the glory of the US manufacturing represented by the automobile industry no longer exists.¹³ From 2017 to 2022, the market share of the automobile manufacturing industry will find it difficult to stop the falling trend in the US.

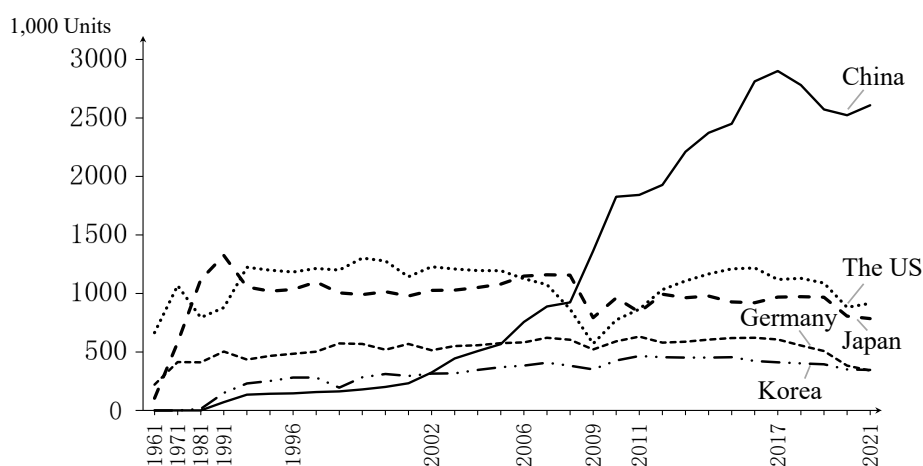


Figure 3: Annual Automobile Production of World’s Major Automakers (1961–2021)

Data Source: The author drew the line chart based on data from the US Department of Transportation.

The rise and fall of the automobile industry in Japan and the Republic

¹³ Ke Lin, Xiangke Lyu, Risks of Path Dependence, Lock-in Effect and Cluster Development – Case Study on the Automobile Industry Cluster in Detroit of the United States, *Regional Economic Review*, No. 1, 2015, pp. 108–113.

of Korea on the one hand and the US automobile industry on the other hand have made the US government feel in crisis. In particular, the huge quantity of exported cars from Japan to the US was a heavy blow to the domestic US automakers, causing “the Big Three” to lose money as their profitability was undermined and causing loss of a large number of jobs related to automobile manufacturing. To defuse the unfavorable situation and appease the discontent of the public, the US government immediately took countermeasures to protect the domestic automobile industry and demanded that Japan restrict automobile exports to the US. Japan finally reached an agreement with the US after negotiations. Japan would limit automobile exports to the US within 1.68 million vehicles in 1981 and raise the quota appropriately on the original basis in the second year. This agreement restricted the production capacity of Japanese automakers and led to a significant price increase of Japanese cars in the US market, thus giving the American automakers some breathing space.

Since the beginning of the 21st century, China has made a giant leap in the automobile industry, benefiting from the enormous domestic market and the globalization bonus after joining the WTO. In 2009, China became the largest automobile producer in the world. The automobile industry has a very positive impact on China’s national economy. The automobile industry contributed to GDP as high as 10% as of 2020¹⁴ and created over 30 million jobs directly or indirectly, including more than 10% of urban employment in China.¹⁵ However, compared with the US, Japan, Germany and other countries, China lacks of core technology support to become a great power. Chinese automakers are technologically less competitive in the three core parts of engine, transmission and chassis and therefore have weak influence on the automobile industry chain. At the same time, most core patents are held by countries such as Germany, Japan and the US who control the formulation of industrial standards and build huge technological barriers against China. Furthermore, China’s

14 National Development and Reform Commission, Stabilize Auto Consumption to Break through the Bottleneck of Auto Industry, https://www.ndrc.gov.cn/fggz/jyysr/jysrsbxf/202003/t20200311_1222869.html?code=&state=123 (Last Visited on November 20, 2022).

15 CCTV, Deeper Understanding of Auto Consumption, <https://auto.cctv.com/2022/07/18/ARTIDOfyCiFKTbjrdIArJD220718.shtml> (Last Visited on November 20, 2022).

automobile market is still dominated by joint venture brands and local brands are less competitive in the market. Therefore, China does not have a solid position in global automobile manufacturing.

B. Automobile Electrification: “Revolutionary” Technology Change Reshapes the Global Competition Landscape

History tells us that “revolutionary” changes of industries and technologies offer rare chances for latecomers to catch up. Over the past century, the emergence and transfer of global automobile manufacturing centers were largely synchronous with the transfer of global industrial centers and were closely related to the “revolutionary” technology changes. The replacement of steam engines by internal combustion engines in the second half of the 19th century is a “revolutionary” change in the power system of transportation vehicles. The United Kingdom and France, which got stronger during the First Industrial Revolution, could not get rid of the “path dependence” on old technologies. As a result, the US was able to seize the opportunity and completely replace the United Kingdom and other countries with the development of gas-powered car technology, becoming an industrial power. During the two oil crises in the 1970s, the emerging microelectronics technology and rocketing oil price paved the way for small-displacement cars with lower fuel consumption, causing traditional large-displacement heavy-duty cars to lose the market share, thus providing opportunities of market expansion for automakers from Japan and the Republic of Korea.

Nowadays, a new round of “revolutionary” technological changes in the automobile industry is unstoppable. The vehicle electrification technology has triggered a powerful “butterfly effect” in the automobile industry. On the one hand, EVs provide feasible solutions for enhancing energy security and reducing carbon emissions. According to the statistics on carbon emissions by sector in various countries, the transportation sector is one of the major sources of carbon emissions, accounting for 25% of the total global carbon emissions and even as high as 37% of total emissions in the US.¹⁶ The promotion of EVs

¹⁶ IEA, IEA Greenhouse Gas Emissions from Energy, <https://www.iea.org/data-andstatistics/data-product/co2-emissions-from-fuel-combustion> (Last Visited on November 18, 2022).

is an important way for countries to address distributed carbon emissions and meet carbon emission reduction commitments. It also helps major industrial countries to reduce dependence on crude oil imports.

On the other hand, with the shift from fuel vehicles to EVs, the original industrial chain and technology routes are undergoing fundamental changes. For the auto parts, EVs use motors and supporting power batteries and electrical control systems instead of fuel generators and transmissions, which renders the accumulated core technologies for fuel vehicles in a century useless for EVs. The latecomers in the automobile industry are likely to achieve “overtaking on curves” by taking advantage of new technological route. In the meantime, the change of power source will severely impact on the demand for fossil fuels and drive up the demand for critical minerals used in power batteries such as lithium, cobalt and nickel. It is expected that in the following 30 years, the market share of auto parts for fuel vehicles will decrease from 26% to 11% and the exclusive key parts for EVs will take up 52% of the market.¹⁷

This new round of technological change brings the countries to the same starting line on the new track of EVs and may bring about a reshuffle of the competition in the automobile industry and even the industrial competition among major countries. A new transfer of the global industrial center is evident in the current trend of centralization of EV sales and production. As far as the consumer market is concerned, China, the US and Europe became the most important sales centers of battery electric vehicle (BEV) in 2021 and had remained it nearly a decade. India also has the potential to become the fourth largest EV market in the future. As can be seen from the brand distribution in Figure 4, the top six EVs automakers, all from China, the US and Europe, seized over 50% of the market share in 2021. The US and Germany had distinct advantages. Tesla alone earned about 14% of market share. Volkswagen, BMW and Mercedes-Benz in Germany ranked among top ten. China followed the US and Germany, with BYD ranking third after Tesla in the US and Volkswagen

¹⁷ McKinsey & Company, *Why the Automotive Future Is Electric*, <https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/why-the-automotive-future-is-electric> (Last Visited on October 27, 2021).

in Germany. The prosperity of EV production and sales is also reflected in the blooming power battery industry. Compared with the complete vehicle manufacturing industry, the concentration of the power battery industry is more obvious. According to Figure 5, as of 2021, the world's top five power battery

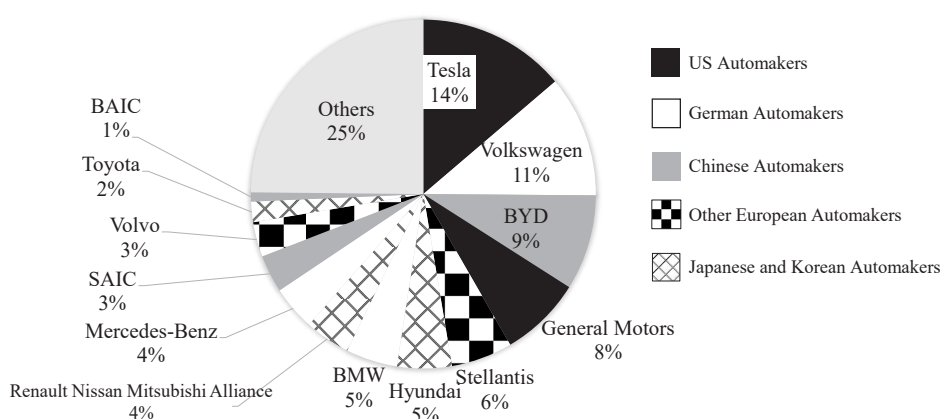


Figure 4: Global Market Share of Major New Energy Vehicle Manufacturers in 2021

Data Source: The author drew the pie chart based on data from EV-Volumes.

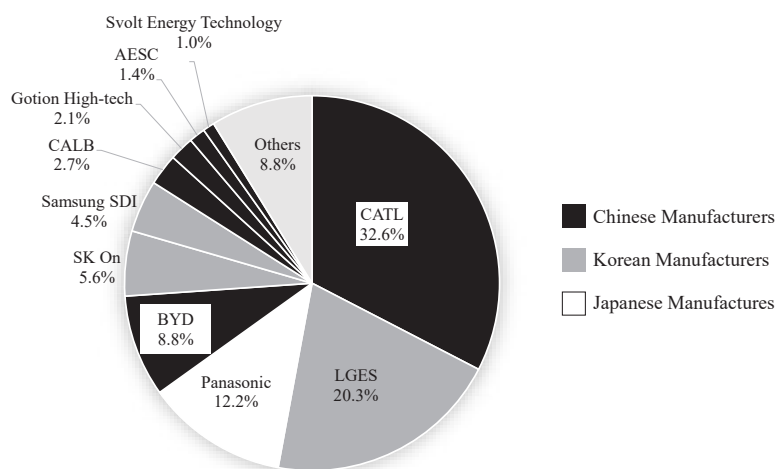


Figure 5: Global Market Share of Major EV Battery Manufacturers Battery Manufacturers in 2021

Data Source: The author drew the pie chart based on data from EV-Volumes.

manufacturers are all from China, Japan and Republic of Korea, reaching as high as 79.5% of global market share. Among them, CATL in China leads the way, far suppressing the subsequent Korean manufacturer LG New Energy, and has significant advantages in power batteries.

Holistically speaking, China, the US and Germany are leading the EV industrial competition. The Republic of Korea and Japan are waiting for a chance to catch up. However, this competitive situation has not stabilized and has gone beyond the scope of competition among enterprises. It is affected by the intervention of state actors to a large extent.¹⁸ The coming rivalry around EV is also an important aspect of competition among major countries.

II. EV POLICY OF MAJOR COUNTRIES

Based on the strategic value of EV industry in the future industrial competition, major countries and regions such as China, the US, European Union (EU) adopt a series of industrial policies to promote local EV production and sales and guide technological changes to get ahead in the new round of competition in the automobile industry by releasing political signals. As more and more entities entered the EV “track”, fierce external competition strengthens the intensity of countries’ use of policy instruments.¹⁹ Industrial policy is becoming an important means to win the EV industry competition.

A. The US: Industrial Reshoring Driven by National Strategies

The pressure of industrial competition from China and the risks of supply shortage caused by the COVID-19 pandemic have exposed the supply chain security issues that is deeply rooted in the “hollowing out” of manufacturing industry in the US.²⁰ At the time of the EV industry revolution, the Biden (Joseph

18 Davis Dyer, Malcolm S. Salter and Alan M. Weber, *Changing Alliances*, Boston: Harvard Business School Press, 1987, pp. 62–65.

19 Jonas Meckling and Jonas Nahm, The Politics of Technology Bans: Industrial Policy Competition and Green Goals for the Auto Industry, *Energy Policy*, Vol. 126, 2019, pp. 470–479.

20 Wei Li and Li Wang, Analysis on the Supply Chain Resilience of the Biden Administration, *Contemporary American Review*, Vol. 6, No. 2, 2022, pp. 1–24.

R. Biden) Administration is using national strategies of national security and climate change for industrial mobilization to encourage “reshoring” of the industry chain. In May 2021, Biden mentioned the threat posed by China and China’s EV industry while inspecting Ford Motor Company’s factory in Michigan, saying that the US lags behind China in both EV market size and battery production. The US is competing with China to lead the global EV market.²¹ In June 2021, the Biden Administration released a 100-day supply chain review report that reviewed the supply chains of four key products including large-capacity batteries. The report noted that the passive role of the US in the battery supply chain would affect the economic security and carbon emission reduction commitment, which shows that power battery is becoming an important part of the industrial strategy of the US.²² In response, the Biden Administration has approved several policies and programs to accelerate local EV development.

First, in terms of consumer side of the market, the US government provides tax deduction for eligible EV transactions. Other measures are taken to boost EV sales and further cultivate EV consumer market, including improvement of charging infrastructure and initiation of public procurement.²³ The yearly expenditure of tax deduction for EV transactions has increased from about \$200 million to about \$1.4 billion since 2018, effectively driving up EV sales growth in the US. The Inflation Reduction Act passed in August 2022 will also continue to inject energy to stimulate EV sales. A tax credit of \$4,000 or \$7,500 is offered to used or new EVs purchased by low- and middle- income individuals in the US. With regard to infrastructure and public procurement, according to the Infrastructure Investment and Jobs Act passed in November 2021, \$7.5

21 The White House, Remarks by President Biden on the Electric Vehicle Manufacturing Boom in America, <https://www.whitehouse.gov/briefing-room/speeches-remarks/2022/09/14/remarks-by-president-biden-on-the-electric-vehicle-manufacturing-boom-in-america/> (Last Visited on October 3, 2022).

22 The White House, Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-based Growth, <https://www.whitehouse.gov/wp-content/uploads/2021/06/100-day-supply-chain-review-report.pdf/> (Last Visited on October 17, 2022).

23 Jianguo Liu et al., New Climate Change Policy of Biden Administration and the Influence, *International Economic Review*, No. 6, 2021, pp. 161–176.

billion would be invested in the construction of EV charging infrastructure and \$7.5 billion would be used to purchase electric school buses.²⁴

Second, in terms of production and manufacturing, the US government supports local EV and power battery manufacturing with tax deduction, funds grants and loans, accelerating the construction of a local industrial ecosystem for EVs. Affected by the negative consequences of “offshore manufacturing” in the early stage, the continuous outflow of US manufacturing over the past decades has made it hard to meet domestic demand with existing capacity. Therefore, the US introduces foreign manufacturers of complete vehicle and power battery to promote the “reshoring” of automobile manufacturing and create EV supply chain of the US and its “allies”. For example, the Advanced Technology Vehicle Manufacturing (ATVM) approved by the US Department of Energy stipulates that the recipient should be within the territory of the US. Up to now, ATVM has provided loans to American automakers such as Tesla, Ford and other automakers as well as the battery manufacturers jointly invested by LG Energy Solution and General Motors.

The US efforts to the “reshoring” of the automobile manufacturing are more evident in the Inflation Reduction Act, which requires that the final assembly of benefited EVs should be within North America and that at least 40% of the critical metals for the battery used by such applicable EVs should be supplied by the US or partner countries from the Free Trade Agreement (FTA) (Canada, Australia, the Republic of Korea, Mexico, Peru, Chili, etc.). The percentage will increase to 80% in 2027.²⁵ The Act directly influences the strategies of all countries and the industry-leading companies. Shortly after the adoption of the Act, LG Energy Solution, one of the world’s largest power battery manufacturers, announced that it will strengthen the supply of raw materials sourcing in North America. It signed battery raw materials purchase agreement with three mining companies in Canada for the first time and

24 The House Committee on Transportation and Infrastructure, *Infrastructure Investment and Jobs Act*, <https://democrats-transportation.house.gov/committee-activity/issue/infrastructure-investment-and-jobs-act> (Last Visited on October 17, 2022).

25 The US Congress, H.R.5376 – Inflation Reduction Act of 2022, <https://www.congress.gov/bill/117thcongress/house-bill/5376/text> (Last Visited on October 17, 2022).

expressed its intention to build a complete supply chain in the US.

Currently, the EV industry strategies of the US are showing results. Since Biden took office as president, major enterprises have announced over \$85 billion investment in new energy vehicles, batteries and charging piles. The US domestic EV sales achieved 105% year-over-year growth in 2021, reaching a new record high.²⁶ With the landing of the investment projects, the EV industry of the US will probably grow faster.

B. EU: Carbon Emission Reduction Commitment Accelerates Industrial Revolution

EU is a “front-runner” in global climate governance and carbon emission reduction and also takes the lead to promote EV development. Based on the carbon emission reduction targets proposed in 2019, the EU passed the “Fit for 55” package in 2021, further proposing carbon emission reduction targets for the automobile industry. It aims to realize zero emission of passenger cars and vans newly registered in EU by 2035. Subsequently, the European Commission, the European Parliament and member states formally reached an agreement and resolved to prohibit the production of new fuel vehicles from 2035.

To realize the top-level targets, the EU unveils a series of EV industry policies, including fiscal incentives, infrastructure improvement and carbon taxes. It also underlines the building of local power battery industry chain.²⁷ The European Parliament passed the long-discussed New Batteries Regulation with the highest number of votes on June 14, 2023.²⁸ It sets higher requirements on standards such as carbon emission and battery performance. Furthermore, it highlights the efforts to strengthen regulation of the supply chain of battery

26 The White House, FACT SHEET: President Biden’s Economic Plan Drives America’s Electric Vehicle Manufacturing Boom, <https://www.whitehouse.gov/briefing-room/statements-releases/2022/09/14/factsheet-president-bidens-economic-plan-drives-americas-electric-vehicle-manufacturing-boom> (Last Visited on October 17, 2022).

27 Siyu Jiang, EU Energy and Climate Policy and Sino-EU Cooperation under Carbon Neutrality Goal, *International Economic Review*, No. 1, 2022, pp. 134–154.

28 European Parliament, Making Batteries More Sustainable, More Durable and Better-performing, <https://www.europarl.europa.eu/news/en/press-room/20230609IPR96210/making-batteries-more-sustainable-more-durable-and-better-performing> (Last Visited on June 27, 2023).

manufacturers to ensure the compliance of the battery value-chain with the obligations of human rights and due diligence. The technical trade barriers are hence created to some extent, affecting a few certain countries, especially China who has disputes with Europe on the issue of “human rights”. In order to reduce import dependence and strengthen EU strategic autonomy in battery supply chain, the European Commission has approved two battery supply chain projects since December 2019 and will provide financial support for Tesla, BMW and other manufacturers to make battery in Europe, covering the entire industry chain, including raw materials extraction, battery manufacturing and recycling.²⁹

C. China: Cultivation of Emerging Industries from “Policy Support” to “Market Orientation”

The vigorous development of EV industry in China is attributed to early policy support and later market activation. There are roughly three stages of policy support. The first stage is the policy pilot period. Before 2012, the Chinese government first set the strategic goals for EV development and made the “three verticals and three horizontals” technology research and development layout, and launched pilot demonstration projects across the country. During this period, nearly 100 complete vehicle companies and parts manufacturers sprang up and harnessed key technologies. The EVs independently developed by China have been seen in the Olympics, World Expo and other international events since 2008.

The second stage is the policy-driven period. From 2012 to 2015, the Chinese government strengthened the promotion of EVs based on the pilot projects. It not only increased fiscal and tax subsidies, but also encouraged the use of EVs in the public sectors to advance EV industrialization. The sales of new energy vehicles in China have reached 330,000 units in 2015, making China the world’s largest sales market.

²⁹ European Commission, State Aid: Commission Approves €2.9 Billion Public Support by Twelve Member States for a Second Pan-European Research and Innovation Project along the Entire Battery Value Chain, https://ec.europa.eu/commission/presscorner/detail/en/IP_21_226 (Last Visited on November 7, 2022).

The third stage is the subsidy removal period. China's EV industry has been driven by policy and market since 2016. On the one hand, China was gradually lifting restrictions on the number of BEV joint ventures and the foreign equity ratio.³⁰ As a result, more international competitors are introduced to local EV manufacturing. Large multinational automakers such as Nissan, BMW, and Volkswagen have accelerated the EV production in China. Tesla commenced the construction of Shanghai factory in early 2019 and the factory was put into operation at the end of the same year. On the other hand, the government's subsidies for purchase of new energy vehicles, including BEV, had declined and were canceled at the end of 2023. This have further guided Chinese automakers to adapt to international market competition with technological research and development. Based on the early industry cultivation efforts and the release of market vitality, the production and sales of EVs in China maintained a strong growth momentum in 2021.

D. Japan and the Republic of Korea: The Choice of "Track" Decides Industrial Development

Japan and the Republic of Korea are no match for China, the US and EU in terms of domestic resources and market size; therefore, they focus on certain "tracks" to avoid the unfavorable conditions. Their choice has decided their position in the global EV industry competition. As the automobile industry is under huge pressure to transform itself, the Japanese government supported local automakers to focus on hybrid electric vehicles (HEV), letting great opportunities of electrification slip away and falling behind in BEV production and sales. As shown by Figure 4, Toyota with long-term dominance over global automobile manufacturing held only about 2% of EV market share, lagging behind its major competitor Volkswagen (11%), US Competitor General Motors (8%) and the industry leader Tesla (14%).

³⁰ The same foreign investor could partner with Chinese investors to establish several joint ventures to produce BEV products since July 28, 2017. The number of such joint ventures were limited to two or less. China would be removing the limitations on the foreign equity ratio of automakers over a five-year transition period since July 28, 2017.

What's more, due to the lack of lithium mines and other natural resources within the territory of Japan, the Japanese government initially failed to clarify the technology roadmap for lithium-ion batteries in the power battery industry, but instead formulated a long-term plan to develop hydrogen energy technology. In the Automobile Industry Strategy (2014) published in 2014, Japan deployed measures to promote fuel cell electric vehicle (FCEV) and the required infrastructure.³¹ It also established the FCEV development objectives by 2040. However, as lithium-ion batteries have been selected as the mainstream power source by the market, although Japan is the inventor of lithium-ion battery, its power battery industry lags far behind the Republic of Korea and China. Sony, a forerunner of lithium-ion battery, has even almost disappeared from the industry. In light of the urgent transformation needs, the Japanese government published the Storage Battery Industry Strategy in September 2022 to support local lithium battery industry.³² The Japanese automakers also have accelerated investment in factories in other countries and made aggressive EV production plans to change Japan's unfavorable situation in the EV industry as soon as possible. Apparently, as a great power in global automobile industry, the Japanese government and automakers have been slow in the process of electrification transformation. It further shows that Japan is better at progressive technological innovation and is not effectively coping with "revolutionary" technological innovation.

Another major automaker, the Republic of Korea, generally outperforms Japan in EV development. Hyundai Motor, the largest automaker in the Republic of Korea, ranks sixth in the world in terms of EV sales, while among the top five in terms of the total sales including fuel vehicles. It can be seen that the Republic of Korea is doing better in EV industry than the industry of fuel vehicles. Other Korean local brands remain almost unknown in the EV industry. Therefore, the Republic of Korea is also struggling like Japan to promote the

31 Shiquan Zuo, Shijia Zhao and Yueyan Zhu, Foreign Policy on New Energy Vehicles and Implications for China, *Economic Review Journal*, No. 1, 2020, pp. 113-122.

32 China Industrial Association of Power Sources, Japan Published Storage Battery Industry Strategy, <https://www.ciaps.org.cn/news/show.php?itemid-39401.html> (Last Visited on November 30, 2022).

transformation of automobile industry.

Although the Republic of Korea is left behind in complete vehicle development, unlike Japan, the Republic of Korea government and automakers have built strong international competitiveness in the power battery industry with a keen insight and early planning in the power battery industry. As early as when the power battery sprang up, Samsung, LG and other large enterprises began to invest heavily in the development of lithium-ion batteries, building advantages for the Republic of Korea's power battery industry in resources, workforce and costs and breaking into the international market. The Republic of Korea has now become the second largest power battery manufacturer after China, but the Republic of Korea government has greater ambitions. The Republic of Korea government published the K-Battery Development Strategy in 2021, further consolidating the strategic role of battery technology in the national strategy. It cooperated with LG Energy Solution and other major local power battery manufacturers to establish the Power Alliance, aiming to fully support the Republic of Korea to become the “overwhelming number one” in this field by 2030.³³ With the “whole-of-nation” support of the Republic of Korea, the Republic of Korea battery “giant” (LG Energy Solution) has accelerated its global capacity expansion since 2021, challenging the top position of CATL.

With the further implementation of more policies, the global promotion and application of EVs will gear up. To secure a short window of opportunity, the US, the EU and the Republic of Korea are clashing over industrial policies related to EVs. As traditional allies of the US and strong competitors in the EV industry, the Republic of Korea and many European countries have expressed dissatisfaction with the Inflation Reduction Act passed by the Biden Administration and have been bargaining with the US over the formulation and implementation of the Act. At the end of 2022, French President Emmanuel Macron asserted during his visit to the US that the huge subsidies for green industries provided in the Act would affect Europe. The United Kingdom,

³³ Kim Bo-eun, Moon Vows Korea Will Become “Battery Powerhouse”, https://www.koreatimes.co.kr/www/tech/2021/07/133_311844.html (Last Visited on November 23, 2022).

Belgium and other European countries also expressed similar opinions. The Republic of Korea demanded a delay of the effective date of the restrictions in the Act, stating that the subsidy policy discriminates against the Republic of Korea companies and the Act may violate the clauses of US-Korea Free Trade Agreement and the provisions of the WTO. To deal with the negative impacts of the Act on the Republic of Korea, it announced that it would initiate legal proceedings with the WTO if necessary.

Faced with strong oppositions from allies, the Biden Administration had repeatedly responded that the Inflation Reduction Act would be amended and it would dispatch officials to various countries for coordination and communication; however, specific details of the amendment were not disclosed and the communication was not constructive. For this reason, the US Department of the Treasury released the guidelines on EV tax credits in March 2023 and loosened the conditions so that more critical minerals supplied by allies of the US were not subject to the restrictions on country of origin. It demonstrates that the protests of European countries and the Republic of Korea have begun to bear fruit, and it is difficult for the US to exclude the influence of external factors when formulating its industrial policies.

It should be noted that although European countries have basically agreed with the US industrial policies, they have different opinions on the huge subsidy plan of the US. Some officials of the European Commission proposed to increase domestic subsidies, but leaders of some states represented by Belgium refused to get involved in a “subsidy war” with the US. The future framing and improvement of EU’s EV industrial policies may be impeded by internal factors.

In summary, the global EV competition among major countries has fully started. The introduction of a large number of EV related policies and the game about industrial policies have shown the determination of all countries and have propelled the high-speed growth of global EV sales. From 2016 to 2021, the annual global EV sales jumped from 760,000 to 6.89 million vehicles. The global EV sales in 2021 increased by 110% compared with the previous

year.³⁴ Faced with the rapid expansion of the global EV market, all countries are placing more importance on policy instruments to develop and seize new markets. The globalization of production will cause a country's industrial policies to have spillover effects on other countries. The friction and game among states around industrial policies will be more frequent.

III. THREE FOCUSES OF EV COMPETITION

In the future, whether a country can manage the conflict of interests with traditional fuel vehicles and the oil industry, whether it can fully hold core technologies of the industry, and whether it can ensure supply chain security of the mineral resources related to power batteries will become the key to whether it can succeed in EV competition, which will further establish the landscape of global EV industry competition.

A. Competition in State Capacity: Overcoming the “Painful Period” of Transition from the Old to the New

The global EV industry competition is an important test of state capacity, including the ability to overcome the obstacles from vested interests and the ability to provide supporting public goods for industrial development. The transformation from fuel vehicles to EVs not only requires efforts to overcome huge resistance from traditional industries, but also requires a favorable environment for emerging industries. All these tasks rely on strong state capacity to break the “carbon lock-in”.³⁵ The progress of electrification transformation mainly influences two traditional industries of oil and fuel vehicles. For the oil industry, the widespread adoption of EVs will sharply reduce the oil demand in transportation, hence the interested oil corporations

³⁴ China Automotive Technology and Research Center, Nissan (China) Investment Co., Ltd. and Dongfeng Motor Corporation, *Annual Report on New Energy Vehicle Industry in China (2022)*, Social Sciences Academic Press, 2022, pp. 2–3.

³⁵ Michaël Aklin and Johannes Urpelainen, Political Competition, Path Dependence, and the Strategy of Sustainable Energy Transitions, *American Journal of Political Science*, Vol. 57, No. 3, 2013, pp. 643–658.

are motivated to obstruct the adoption or landing of the EV policies. The US is a typical case. As early as the 1990s, General Motors developed EV1 (a type of BEV), but the project aborted due to numerous obstructions from Detroit and oil giants.³⁶ Today, groups supported by oil corporations are lobbying in ten states of the US. In Illinois and Iowa, the American Petroleum Institute (API) and Americans for Prosperity, a political group funded by Koch Industries, are joining hands to oppose utility companies' investments in EVs.³⁷ Although the actions of interested oil corporations are currently limited to lobbying which exerts limited influence, as the threat of EV to fuel vehicles further expands in the future, oil corporations may take more radical measures to oppose or slow down the promotion of EVs. For manufacturers of fuel vehicles, large traditional giant manufacturers are moving slowly toward EVs because of the huge sunk costs, including the upgrading of production line, workforce development and reorganization of supply chain. Therefore, traditional automakers are blocking the electrification of the automobile industry with various reasons, especially the "protection of employment".³⁸ Faced with the resistance from such vested interests, the country should have a clear-cut stand and be resolute in the industrial policies bolstering EV development.

For consumers, the unavailability of charging piles, battery swapping stations and other supporting infrastructure is the main barrier for them to buy an EV, which puts higher demands on the state capacity to supply public products. In terms of supply, although the number of charging piles is showing an upward trend, it still lags behind the growth rate of EVs. The future supply-demand imbalance of charging infrastructure will be deteriorated if the supply could not catch up. In terms of supply distribution, the uneven geographical and temporal distribution of charging resources is common in China, the United

36 Levi Tillermann, *The Great Race: The Global Quest for the Car of the Future*, China Machine Press, 2018, pp. 84–88.

37 Gavin Bade, The Oil Industry vs. the Electric Car, <https://www.politico.com/story/2019/09/16/oil-industry-electric-car-1729429> (Last Visited on November 2, 2022).

38 Dingding Chen, Zeying Wu and Lei Wang, Will China's New Energy Vehicle Industry Be Subject to Political Repression by Europe and the United States? <https://www.ftchinese.com/story/001096802?archive> (Last Visited on November 28, 2022).

States and other countries. There are no charging piles in urban periphery and townships. Congestion at charging stations is very common during holidays. This requires the government to be capable of strengthening investment in infrastructure and to provide a better consumer environment for EVs.

Breaking the path dependence and lock-in effect of traditional technology and industries, the transition from fuel vehicles to EVs is bound to fundamentally change the landscape of interest. The Nokia Moment³⁹ of the automobile industry depends on the state capacity to surmount the obstacles of vested interest groups, release the potential of “creative destruction” proposed by Joseph A. Schumpeter and build consumer confidence by optimizing public product supply.

B. Core Technologies Competition: Building Technological Strength in Electrification and Intelligence

A review of the history of automobile industry shows that it is a technology-intensive industry even after more than a century of evolution. The technological progress in the automobile industry has never stopped. At the time of revolutionary changes of technology, the capacity to lead the development of core technologies is decisive for a state to maintain the dominant role in the automobile industry.

The core technologies of EV industry include information and communication technology (ICT) and BMC (battery, motor and electrical control). Among them, the battery is known as the “heart” of an EV. Its costs take up about 30% to 40% of the total costs of complete vehicle. It largely decides the endurance, charging time, safety and other performances as well as the price of an EV. It also affects consumer’s purchasing decision. Therefore, Tesla, BYD and other mainstream EV manufacturers are accelerating efforts in independent battery research and development while seeking reliable battery manufacturers, but the power battery market will continue to be dominated

³⁹ In the first decade of the 21st century, Nokia’s market share had long been at the forefront of the world, and once ranked first in 2009. However, in the following years, smartphones appeared and rose rapidly, completely replacing traditional feature phones represented by Nokia. This period is called the “Nokia Moment”.

by two “giants” — CATL from China and LG Energy Solution from the Republic of Korea in the short term. Motors and electronic controls are the core parts of the powertrain of an EV. The percentage of their costs in the total costs of complete vehicle is second only to the battery. For the electrical control, nearly half of the global core power device (insulated gate bipolar transistor, IGBT) market is monopolized by German manufacturer Infineon.⁴⁰ Chinese manufacturers are inferior to foreign counterparts in terms of the quality stability, service life and other aspects of the motor control unit. This unfavorable situation is hard to change in the short term. For the motors, Tesla has made technological breakthroughs and has used new motors with lower costs and better performance in EV assembly. Tesla, BYD, Li Auto and other Chinese manufacturers are equally racing for the motor market.

As the intelligence-based development of the automobile industry is deepened, the relevant ICT becomes increasingly important. Currently, Tesla has the world-leading AI-assisted driving technology and it ranks among the world's top in the number of relevant patent applications, creating an absolute advantage in the intelligence-based development of the automobile industry. For other EV manufacturers, the accelerated involvement of Google, Microsoft and other oligopolies in data processing and algorithm in the automobile industry chain will put more pressure on other manufacturers. In addition, chips are the basic hardware of ICT application and the indispensable parts of the electrical system, so chips are also influencing the whole EV industry. In 2021, due to the “shortage of chips” in the automobile industry caused by the COVID-19 pandemic, global automakers reduced production by a total of about 10.27 million vehicles. The supply chain disruption would also lead to extension of the delivery period, causing negative effects on the costs and profits of automakers.⁴¹ Faced with the new wave of technological advancement in the EV industry, major automakers have announced to increase research and development investment to maintain the industry-leading position and to build

⁴⁰ *Supra* n. 34, pp. 27–28.

⁴¹ *Ibid.*, pp. 29–30.

the independent research and development system.

C. Competition for Critical Minerals: Build a Reliable Mineral Resource Supply Chain

The upstream mineral resources of the supply chain are the “blood” and “food” of the industrial system. Unlike fuel vehicles that are highly dependent on oils, the rapid development of EV industry, especially the development of power batteries, is highly dependent on a large and stable supply of minerals, including lithium, cobalt, nickel and other critical minerals.⁴² In particular, lithium ore, known as the “white oil”, is extremely crucial for power battery. However, due to geological activities and other natural factors, mineral resources are distributed in a highly concentrated manner. The “Lithium Triangle” in South America (Chile, Argentina and Bolivia⁴³) holds roughly 58% of global lithium resources and over 50% of global lithium reserves. The Democratic Republic of the Congo holds about 46% of global cobalt reserves and accounts for approximately 69% of global cobalt production. Indonesia and the Philippines hold around 27% of the global nickel ore reserves and account for about 44% of global nickel production (See Table 2 and Table 3).⁴⁴

The above countries have become the hubs of the global mineral supply chain due to the imbalanced distribution and supply of mineral resources. Changes in the production of certain countries can even cause volatility of the global mineral supply and bring more risks to the global mineral supply. In terms of the country of origin, the major suppliers of lithium, cobalt and nickel are exposed to political and economic risks, which may influence the extraction and export of critical minerals. The “Lithium Triangle” in South America proposed to create a “Lithium OPEC” to influence international pricing through

42 Hongtu Zhao, Carbon Neutrality and New Change of International Energy Politics, *Contemporary International Relations*, No. 2, 2022, pp. 29–37.

43 According to the statistics of the United States Geological Survey, Bolivia has the largest proven lithium reserves in the world, but it is not economically feasible to exploit the reserves under current market and technology conditions, so Bolivia is not a competitive player and relevant data is not presented in Table 2.

44 USGS, National Minerals Information Center, <https://www.usgs.gov/centers/national-minerals-information-center> (Last Visited on November 2, 2022).

controlling the lithium production in the three countries.⁴⁵ These restrictive measures further aggravated the supply-demand imbalance in critical minerals and intensified the conflict over resources and the protection of resources. The mineral supply of the Democratic Republic of the Congo was rendered disputable and even under a boycott because of the labor issues. The production may be hindered by international pressure.⁴⁶ As the major nickel ore exporter, Indonesia announced orders to ban nickel ore exports in 2014 and 2020, thereby undermining the supply source stability.

In terms of international factors, the mineral-related economic and trade activities are vulnerable to regional conflicts and great power rivalry. From the perspective of short-term analysis, after the outbreak of the Ukraine Crisis, there were worries about the transaction of nickel from Russia due to sanctions. The nickel price soared, which sparked off the “London Metal Exchange Nickel Short Squeeze” incident, leaving the EV manufacturers dealing with rocketing costs. From the perspective of long-term analysis, the US and its allies have implemented the mineral security strategies in all aspects and have escalated the rivalry with China, which led to a trend of “weaponization” of mineral resources. China’s power battery industry is heavily dependent on foreign sources of critical minerals and the import is concentrated. Among them, the import dependency of lithium ore reaches as high as 74.1%. Lithium ores are mainly imported from Chile and Australia. However, Australia has been involved in the economic and diplomatic conflicts with China in recent years and has always been a supportive ally of the US in its efforts to establish supply chain partnership, which increases the uncertainty in the future import of lithium resources. China’s import dependency of nickel ore is as high as 99.4%, and the main sources are the Philippines and Indonesia. But the Philippines once had disputes with China because of the South China Sea issue and there are signs that the Philippine governments are Pro-American.

45 David R. Mares, Understanding Cartel Viability: Implications for a Latin American Lithium Suppliers Agreement, *Energies*, Vol. 15, No. 15, 2022, p. 5569.

46 Sophia Kalantzakos, The Race for Critical Minerals in an Era of Geopolitical Realalignments, *The International Spectator*, Vol. 55, No. 3, 2020, pp. 1–16.

The risk of critical minerals supply disruption will directly affect the profitability of relevant companies. On the one hand, the imbalanced supply and demand of critical minerals has led to the accelerated concentration of profits upstream, resulting in meager profits for battery manufacturers and even continued losses for EV manufacturers, which is detrimental to the long-term healthy development of the industry. On the other hand, the surge in demand of critical minerals and occasional international incidents have caused violent fluctuation of the price of lithium, cobalt, nickel and other minerals. The price fluctuation transmits to the downstream industry and affects the costs of both EV and power battery manufacturers. In early 2021, with the price of raw materials going up, more than 20 new energy vehicle manufacturers such as Tesla and BYD announced price increases, shadowing the EV promotion.

Table 2: Global Distribution of Lithium, Cobalt and Nickel Reserves

Lithium	Chile 41.8%		Australia 25.9%	Argentina 10.0%	China 6.8%	Others 15.5%
Cobalt	The Democratic Republic of the Congo 45.8%		Australia 18.3%	Indonesia 7.8%	Cuba 6.5%	Others 21.6%
Nickel	Indonesia 22.1%	Australia 22.1%	Brazil 16.8%	Russia 7.9%	Philippines 5.1%	Others 26.0%

Note: The data is about the mineral reserves, not the mineral resources.

Data Source: Based on data from the United States Geological Survey (USGS).

Table 3: Global Distribution of Lithium, Cobalt and Nickel Production

Lithium	Australia 51.7%	Chile 26.4%	China 13.1%	Argentina 5.6%	Others 3.2%
Cobalt	The Democratic Republic of the Congo 69.0%	Russia 6.3%	Australia 4.0%	Others 20.7%	
Nickel	Indonesia 30.7%	Philippines 13.3%	Russia 11.3%	New Caledonia 8.0%	Others 36.7%

Data Source: Based on data from the USGS.

Therefore, a reliable mineral supply chain in the upstream not only ensures the resources for EV manufacturing, but also stabilizes the costs and prices. It is an imperative policy to secure the long-term stable development of the EV industry.

IV. CHALLENGES IN CHINA'S EV INDUSTRY AND RESPONSES

After over 60 years of development, China has laid the groundwork for the industrial chain of the automobile industry, although it has not been able to keep a competitive edge in fossil fuel vehicles. The Chinese government cultivates better industrial ecosystem and market environment for the EV industry with industrial policies, realizing rapid growth in production and sales. On the one hand, China is an enormous market that provides strong impetus for consumption growth. In 2021, the EV sales in the Chinese market accounted for about 52% of the global sales, compared to only 9% of the US. China's relatively low per capita vehicle ownership shows great market potential to be released. Automakers and suppliers of supporting facilities will be further attracted to China. On the other hand, China has also established mature and complete industrial system for automobile manufacturing. Since the 21st century, especially after 2009, China has become the world's largest producer of fossil fuel vehicles and largest producer of EVs. In 2021, China's BEV production reached 2.29 million vehicles, accounting for 57.4% of the global sales, outperforming Europe (22%) and the US (12%) and far exceeding Japan (0.9%).⁴⁷ Tesla, the world's largest EV manufacturer, produced 930,000 vehicles in 2021, more than half of which were "Made in Shanghai".

If China can take the lead in cultivating large-scale EV manufacturers with competitiveness based on the existing advantages, the budding part of EV industrial chain will settle down in China, thereby further uplifting China's

47 Takashi Kawakami, Yohei Muramatsu and Saki Shirai, China Led World with 500,000 Electric Car Exports in 2021, <https://asia.nikkei.com/Spotlight/Electric-cars-in-China/China-led-world-with-500-000-electric-car-exports-in-2021> (Last Visited on October 17, 2022).

position as an industrial power. However, as the international competition intensifies, Western countries and their allies are adopting protectionist industrial strategies. There are still thistles and thorns on the way ahead of China's EV industry.

Firstly, although China has some technological advantages in EV manufacturing to certain degree, it has not established high technology threshold and is even left far behind by some countries in certain aspects. Currently, Tesla is the world leader in the complete vehicle research and development. According to the statistics of the United States Patent and Trademark Office (USPTO), Tesla has 902 patent applications approved, with a grant rate of 80.25%. While China's leading company BYD only has 539 patents, with a grant rate of 69%. When it comes to the research and development of BMC and other key parts, CATL and other Chinese power battery companies own the world-leading technologies, but the strength of other international competitors should not be underestimated, especially the Republic of Korea manufacturer LG Energy Solution. Although LG Energy Solution has always invested less in research and development than CATL, it holds nearly five times as many patents as CATL. At the same time, the market of core power electronic device for EVs is dominated by a few countries, among which Infineon in Germany seizes more than half of the market share. In the field of ICT, the intelligent systems and autonomous driving technologies of Chinese manufacturers Huawei and Baidu are comparable to those of their international competitors and will contribute a lot to intelligent EVs; however, China's heavy reliance on import of automobile chips may hold China back to give full play to its advantages in ICT. The auto production in China was reduced by about 1.98 million vehicles in 2021 due to the COVID-19 pandemic. It is expected that China's chip shortage will remain severe in the next two to three years.⁴⁸

Secondly, China is exposed to many international political risks in the supply of mineral resources for power battery. In recent years, the US has vigorously strengthened mineral diplomacy through multilateral arrangements

⁴⁸ *Supra* n. 34, p. 30.

or partnerships to align with allies and countries with abundant mineral resources to create a controllable mineral supply chain, which could threaten China's access to mineral resources to some extent.⁴⁹ In 2021, Biden presided over the Global Supply Chain Resilience Summit during the G20 Rome Summit, twelve G20 members and four non-members attended the Summit. the Democratic Republic of the Congo was also invited as a major Cobalt exporter. In July 2022, the US convened and presided over the "2022 Supply Chain Ministerial Forum" to tackle near-term bottlenecks and long-term supply chain challenges. Major mineral exporters, Australia, the Democratic Republic of the Congo and Indonesia, were invited to attend the meeting, while China, holding an important position in the industry, was excluded. In addition, the US also established the Minerals Security Partnership (MSP), known as "Metallic NATO", in Canada in June 2022. It seems to direct the spearhead against China. The organization was established by the US and its allies. At the beginning of its establishment, it invited Argentina, Brazil, the Democratic Republic of the Congo and other minerals-rich countries to attend the MSP meetings. The MSP aims to build a supply chain for the interests of the US to compete with China.⁵⁰ After the establishment of MSP, Canada ordered the divestiture of the investments by three Chinese companies in Canadian critical mineral companies for national security concerns in early November 2022.⁵¹ The mineral resources involved in this incident mainly include lithium ore required for power batteries. This was just a glance of its ambition to hit China's EV industry.

Thirdly, the development of China's local EV industry chain faces the challenge of "pan-securitization". The development of EV intelligence is accompanied with the issue of security, which makes it difficult for foreign EV

49 Hongyuan Yu, Chenglong Guan and Zhe Ma, Critical Minerals Strategy of Biden Administration, *Contemporary International Relations*, No. 11, 2021, pp. 1-8.

50 Anjian Wang and Xiaojing Yuan, Analysis on the Critical Minerals Security of China under Major-power Rivalry, *Bulletin of Chinese Academy of Sciences*, Vol. 37, No. 11, 2022, pp. 1550-1559.

51 Andy Home, Canada Slams the Door on China in Critical Minerals Race, <https://www.reuters.com/markets/commodities/canada-slams-door-china-critical-minerals-race-2022-11-07/> (Last Visited on December 1, 2022).

manufacturers in China to avoid certain political risks, so they will be more cautious when making investment in China. In 2021, as the world's largest EV manufacturer, Tesla accounted for 10.7% of the total EV sales in China and 13.6% of the total EV production in China,⁵² which is of great significance to improve the EV industrial chain in China, but it has encountered dual security pressures from China and the US. In terms of data security, because SpaceX, owned by its CEO Elon R. Musk, has close business ties with the US Military, China has strong security concerns about the data collected by its autonomous driving system and is worried that the data will be accessed by the US government. In terms of security review, the US Congress is also pressing ahead with a legislation to review the investment of American companies in China to protect the technology and supply chain of the US,⁵³ which will undoubtedly have an adverse impact on Tesla's business in China. The pressure from China and the US has put Tesla's factory in Shanghai in the eye of the storm. As Sino-US competition intensifies, Tesla will be facing more uncertainties in China. Musk announced the plan to build the fifth Tesla factory in Mexico in March 2023. If Tesla reduces its reliance on its Shanghai factory in the future due to various non-commercial considerations, this will have a negative impact on China's local EV ecosystem.

Fourthly, China's EV manufactures are facing more barriers to enter the international market due to geopolitics and protectionism. The automobile industry is a typical industry with economies of scale. China needs to expand into global markets but large-scale global expansion will encounter many difficulties. In the US market, the top five EV manufactures accounted for 78% of the market share in 2022, and none of them is from China.⁵⁴ In the same year, while China's total EV exports increased significantly, exports

⁵² *Supra* n. 34, p. 8.

⁵³ Gavin Bade, *Lawmakers Push New Compromise for Screening American Investments in China*, Politico, <https://www.politico.com/news/2022/06/13/lawmakers-push-new-compromise-for-screening-american-investments-in-china-00039282> (Last Visited on December 3, 2022).

⁵⁴ Abhik Mukherjee et al., *EV Sales in US up 54.5% YoY in 2022; Tesla Market Share at 50.5%*, <https://www.counterpointresearch.com/insights/us-ev-sales-2022/> (Last Visited on June 27, 2023).

to the US plummeted and Chinese companies were conservative in building factories in the United States. In contrast, LG Energy Solution and Toyota and other Japanese and Korean automakers invested more in the automobile manufacturing in the US to capture the high-potential US market. This is because while attracting foreign investment, the US set market entry barriers and released negative signals to Chinese companies to decouple from China's EV industrial chains. On the one hand, the US government restricts China's EV industry for reasons of "forced labor" and "entity of concern". The Inflation Reduction Act provides that the battery components shall not be supplied by the "entities of concern" in certain countries starting in 2024. According to the definition of "entity of concern" under the US law, Chinese companies are most likely identified as entities of concern. In November 2021, the US Department of Energy published an announcement, pointing out that the effects of China's "forced labor" on the EV supply chain must be studied, which could be the hidden danger for the expansion of Chinese companies into the US market.⁵⁵ On the other hand, the tendency of US politicians to advocate decoupling from China may affect the collaborations among companies. Currently, the partnership between Tesla and CATL has unsettled some US politicians, who claim that the cooperation with Chinese automakers would cause technology leakage and supply chain crisis, jeopardizing the national security of the US.⁵⁶ The series of actions taken by the US have a direct influence on the choices of Chinese manufacturers. After the issuance of the Inflation Reduction Act, China's battery manufacturer CATL immediately shelved its plan to set up a factory in the US and instead announced a partnership with Ford to set up a factory in the US with Ford as the wholly-owned shareholder and CATL providing technological and service support. At the same time, it also turned its

⁵⁵ Vehicle Technologies Office of Energy Efficiency and Renewable Energy, Battery Policies and Incentives Search, <https://www.energy.gov/eere/vehicles/battery-policies-and-incentives-search#/?show=result&id=64/> (Last Visited on November 2, 2022).

⁵⁶ Akhil Ramesh, The US Should Take Musk's China Entanglements Much More Seriously, <https://thehill.com/opinion/international/3707986-the-us-should-take-musks-china-entanglements-much-more-seriously/> (Last Visited on November 2, 2022).

attention to the European market.

With the increasing procurement of EVs by major European countries, the European market is thriving; however, Chinese automakers do not hold competitive advantages in the European market. In 2021, Chinese automakers held only 14.7% of the European market share, half of which was contributed by Tesla's Shanghai factory. If Tesla's factory in Germany escalates the capacity, China's market share will be nibbled by the US in the future. There is also huge potential demand for EVs in Asia and other emerging markets, especially India, but China's EVs have been obstructed by geopolitical challenges when penetrating the Indian market. In early January 2020, Great Wall Motor reached an agreement with General Motors to acquire GM's Talegaon factory with \$1 billion to pave the way for development in India.⁵⁷ However, the deal was not approved by the authorities after over two years of negotiation because of the China-India relations.

Generally speaking, although China's EV industry has gained some first-mover advantages due to the timely and effective industrial support policies in the past decade and the huge domestic market size, it still faces severe challenges of "being blocked by the US in front and pursued by Germany, Japan and the Republic of Korea in the back". China's EV industry should not be confined to the "internal circulation". It needs to "go global" while steadily expanding domestic market to compete in the broader international market, which requires both domestic and international strategic design.

At the level of domestic development, China should support leading companies to speed up innovation and promote production and sales by upgrading production technology and improving product performance to achieve the benefits of scale. The unit cost of vehicles is extremely sensitive to output. According to the experience of Tesla, it gained significant profitability after the annual sales surpassed 900,000 vehicles in 2021 with a profit ratio

⁵⁷ CNBC, General Motors Calls off Plan to Sell India Car Plant to China's Great Wall, <https://www.cnbc.com/2022/07/01/general-motors-calls-off-plan-to-sell-india-car-plant-to-chinas-great-wall.html> (Last Visited on November 2, 2022).

of 10.5%.⁵⁸ In 2021, the production volumes of BYD and SAIC, the top two companies in China, were 526,000 and 420,000 vehicles respectively. Although they are far ahead of Great Wall Motor, which ranks third in China, they have not achieved economies of scale and have a lower profitability. Hence, they need to increase capacity to reverse the loss-making situation and build strong financial foundation for participating in international competition.

Furthermore, the Chinese government should strengthen investment in charging infrastructure to support EV consumption and stimulate domestic consumption so that it will not follow the same old road of the United States in the mid-20th century when it was under pressure from subdued domestic demand. Specifically, China can initiate pilot projects in the regions with rich renewable resources to promote EV sales and the construction of charging and energy storage facilities. The wind power, solar power and other power resources with poor stability are supplied to EVs at a favorable price to optimize the allocation of power resources.

At the international level, China should carry out economic diplomacy to “escort” the rising of China’s EV industry. On the one hand, China should establish bilateral dialogue mechanism and multilateral critical minerals supply alliances with mineral-rich countries to enhance the capacity for sourcing of mineral resources. It should also actively attend the global mineral resource governance mechanisms such as the International Mines Ministers Summit (IMMS) to ensure the minerals supply chain security. On the other hand, China should also maintain communication with major consumer markets and vigorously encourage Chinese automakers to make foreign investment to promote the localization of production, which can avoid possible political and trade barriers and help build a global automobile industry chain.

In short, as a new round of revolutionary technological change in the power segment is happening in the automobile industry, the global competition is undergoing “unprecedented changes in a century”, which gives China a golden

⁵⁸ Mark Kane, Tesla Q4 2021 Final EV Delivery Numbers and Outlook, <https://insideevs.com/news/563407/tesla-2021q4-final-delivery-numbers> (Last Visited on November 2, 2022).

opportunity to “overtake on curves” in the automobile industry. Considering the vital position of automobile manufacturing in the entire industrial system, the rising of China in the EV industry will further change the basic direction of the global industrial development history over the past two hundred years.