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THE GLOBAL AUTOMOTIVE SECTOR AFTER THE PANDEMIC: KEY QUESTIONS AND ANSWERS

by Lorenzo Bencivelli*, Alessio Ciarlone*, Emidio Cocozza*,
Andrea Gerali*, Andrea Perin* and Carmine Porello*

Abstract

This paper examines the major structural transformations that have been reshaping the global automotive industry since the COVID-19 pandemic. Organized as a series of questions and answers, it analyses key developments across market dynamics, electrification, trade policy, supply chains, and digital technology. The post-pandemic recovery has been strikingly uneven: while China's vehicle sales surpassed pre-pandemic levels, advanced economies – particularly in the European Union – remain significantly below 2019 volumes, reflecting weakened affordability and policy uncertainty. China's rapid rise as the world's largest electric vehicle producer and exporter, driven by sustained industrial policy, battery supply chain dominance, and an estimated 30 to 45 per cent manufacturing cost edge over Western competitors, has fundamentally altered competitive dynamics. European, Japanese, and Korean original equipment manufacturers face mounting pressure from Chinese electrification, trade fragmentation, and the transition to software-defined vehicles, where Chinese firms are estimated to have a two- to three-year lead. US and EU defensive measures—including prohibitive tariffs and countervailing duties—have proved only partially effective, with EU passenger car imports from China rising by nearly 30 per cent in 2025. The paper concludes that diverging industrial, trade, and environmental policies are fragmenting global automotive markets into distinct regional ecosystems, raising costs, complicating investment, and accelerating a structural realignment of competitive advantage.

JEL Classification: L62, F13, O33.

Keywords: electric vehicles, trade policy, automotive industry.

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Introduction[1]

Organized as a series of questions and answers, this paper examines the major transformations reshaping the global automotive industry since the pandemic focusing on the sector’s most consequential developments and their strategic implications. The period considered has been marked by an uneven recovery in demand, and the growing interplay between electrification, digital technologies, and trade and industrial policy tensions among major economies. Together, these forces are redefining the competitive landscape of the automotive industry, with China emerging as the key player across electric mobility, battery supply chains, and software-enabled vehicles.

The recovery in automotive demand has been highly uneven across regions. While China has fully recovered, supported by sustained incentives for zero-emission vehicles, demand in most advanced economies remains well below pre-pandemic levels, particularly in the European Union, Japan, and the United Kingdom, reflecting weaker affordability and persistent policy uncertainty.

Electrification has accelerated the redistribution of competitive advantage. In 2025, China accounted for nearly two-thirds of global electric vehicle (EV) sales and remained the world's largest exporter, while European original equipment manufacturers (OEMs) face the challenge of financing the transition to EVs without undermining the profitability of their internal combustion engine (ICE) business. This advantage is reinforced by China's dominance of the lithium-ion battery value chain, which provides Chinese manufacturers with vertically integrated supply chains and an estimated 30–45 percent cost advantage that Western diversification efforts have yet to meaningfully erode.

Competition is also shifting toward software-defined vehicles. Chinese automakers are estimated to be two to three years ahead of international competitors in software development cycles, creating the possibility that their current lead will translate into a durable technological advantage. At the same time, the rapid diffusion of connected vehicles is raising new data governance and cybersecurity concerns, making regulation an increasingly important dimension of competition.

Trade policy has become another key driver of market outcomes. The United States has effectively closed its market to Chinese automakers through a combination of prohibitive tariffs and restrictions on information and communications technology (ICT) and data governance. At the same time, higher U.S. tariffs on vehicles and components are placing

[1] We thank Riccardo Cristadoro e Giovanni Veronese for their valuable comments and insightful suggestions. All remaining errors are our own. The opinions expressed in this paper do not necessarily reflect those of the Bank of Italy.

increasing pressure on the profitability of European, Japanese, and Korean manufacturers. In the European Union, by contrast, countervailing duties introduced in 2024 have so far had only a limited impact: imports of passenger cars from China rose by nearly 30 percent in volume terms in 2025, driven by substantial reductions in battery electric vehicle (BEV) prices and a strategic shift toward hybrid and ICE models that are not covered by the duties.

Overall, the paper argues that diverging industrial, trade, and environmental policies across China, the European Union, and the United States are fragmenting the global automotive market. While these policies pursue distinct strategic objectives, they are also increasing production costs, complicating investment decisions, and reducing efficiency for globally integrated automotive manufacturers.

The remainder of the paper is organized as follows. The next section examines the evolution of the global automotive market and its changing structure. The subsequent section analyzes the industrial transformation driven by the electrification of mobility. The third section explores the geopolitics of the automotive industry, focusing on trade tensions and industrial policies. The fourth and fifth sections examine, respectively, the evolution of battery and critical mineral supply chains and the emergence of software-defined vehicles as the industry's next technological frontier. A complete list of the questions addressed in the paper is provided in the Table of Contents at the end of the paper.

I. Market Structure and Dynamic[2]

Q1. How have global automotive sales developed after the pandemic?

Global automotive sales have broadly returned to pre-pandemic levels, but the recovery has been highly uneven across regions. By 2025, sales in emerging economies were about 13% above pre-pandemic volumes, while most advanced economies had yet to fully recover.

In Europe, light vehicle sales were still significantly depressed, with registrations in the EU and the UK 17% and 13% below 2019 volumes, respectively. Japan also remained 11% below its pre-pandemic level, while US sales were 4% lower.

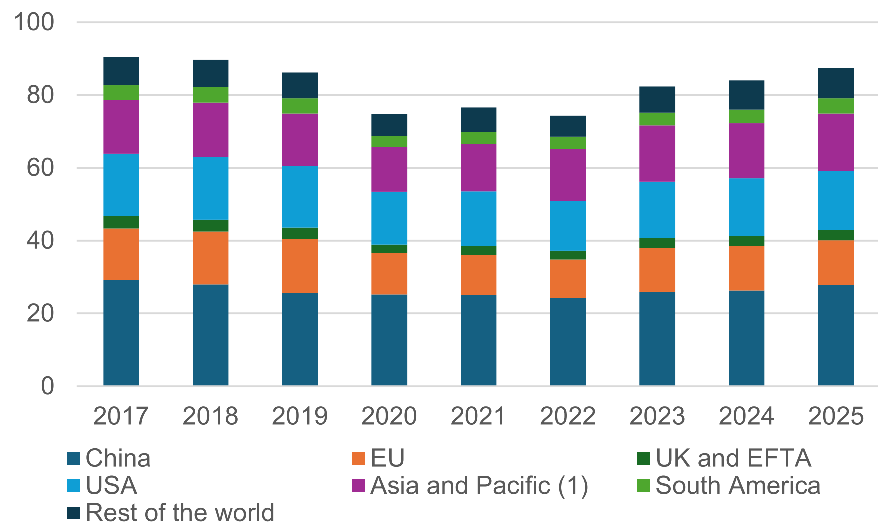
By contrast, sales in China – the world's largest vehicle market – were 9% above their 2019 level, supported by policies promoting zero-emission vehicles. However, volumes remained

[2] In the report, sales data are based on new vehicle registrations, where available, or retail sales. Unless otherwise specified, the term electric vehicle (EV) refers to both battery electric (BEV) and plug-in hybrid electric (PHEV) vehicles, and does not include hybrid electric (HEV), mild-hybrid electric (MHEV) and fuel cell electric (FCEV) vehicles.

below their 2017 peak, suggesting that demand growth was increasingly driven by vehicle replacement, particularly through EV adoption (Figure 1).

Figure 1: Global sales of light vehicles

(*million vehicles*)



Source: Authors' computations on national data for 63 selected markets. (1) Excluding China.

Q2. What explains the incomplete recovery in advanced economies car markets?

The incomplete recovery of automotive markets in advanced economies primarily reflects two factors: weaker affordability and the costs associated with the transition toward electrification. Vehicle prices rose sharply following pandemic-related supply disruptions and remained elevated because of higher financing costs, [3] stricter regulations and manufacturers' shift toward higher-margin models. At the same time, the transition to electric mobility increased technological complexity and production costs while consumer demand adjusted only gradually.

In the EU, these pressures were compounded by the sector's deep integration into global value chains, which amplified the effects of semiconductor shortages and logistics disruptions. The surge in energy and other input costs following Russia's invasion of Ukraine further increased production costs (ECB, 2022, 2024). At the same time, stricter CO_2 targets and new vehicle safety requirements raised technological complexity and accelerated the industry's shift toward electrification and higher-margin models. The resulting increase in vehicle prices appears to have weighed on demand: while household consumption of durable goods rose by

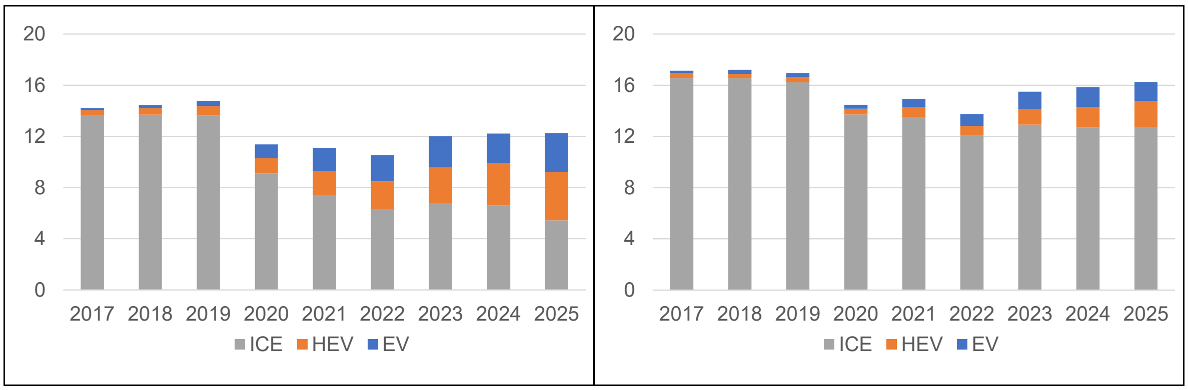
[3] The ECB Consumer Expectations Survey (CES) indicates that limited access to affordable financing options is the main obstacle to purchasing a new car for low-income households (ECB, 2025).

12% in real terms between 2019 and 2025, car registrations remained about 2.5 million vehicles below pre-pandemic levels (Figure 2, Panel a).[4]

Figure 2: Light vehicle sales by powertrain in the EU and US

(*annual data, million vehicles*)

(a) EU (b) US



Source: Authors' computations on ACEA and Argonnne National Laboratory.

The US car market underwent a similar shift toward more expensive models, weighing on affordability. Supply-chain disruptions initially raised prices, while the growing dominance of SUVs and pickups – accounting for about 60% of new retail registrations – further increased average transaction values through changes in the product mix (Cox Automotive, 2026a, 2026b). Meanwhile, the transition toward electrified powertrains became increasingly dependent on policy incentives and regulations, making demand more sensitive to changes in the policy environment. The trade measures and policy uncertainty that emerged in 2025 added further costs and delayed some purchasing decisions (NADA, 2025a), helping to keep sales volumes about one million units below pre-pandemic peak levels (Figure 2, Panels b).[5]

In Japan, the weak recovery reflected the combined effect of high vehicle prices, higher financing costs and structurally subdued demand in a market characterized by an ageing population and low replacement demand. In South Korea, by contrast, the market proved more resilient: after a pandemic-related surge, supported by temporary tax cuts on passenger cars, registrations in 2025 remained close to pre-pandemic levels, while subsidies to electrification were adjusted to counter a temporary slowdown in demand. In both countries,

[4] The European car market is now dominated by SUVs, which account for close to 50% of all new registrations - a direct reflection of the progressive withdrawal of affordable, entry-level models from the market (ICCT 2026). This structural shift has kept average transaction prices persistently elevated (JATO Dynamics, 2025).

[5] The announcement of a 25% tariff on imported automobiles and components in March 2025 – effective on April 3 and May 3, respectively – triggered a strong purchase pull-forward, with annualized light-vehicle sales jumping to near-18 million units as buyers rushed to beat the tariff deadline (NADA, 2025a).

consumers increasingly viewed hybrids as a lower-risk transition technology, although Japan's more cautious approach resulted in a weaker recovery than in Korea.

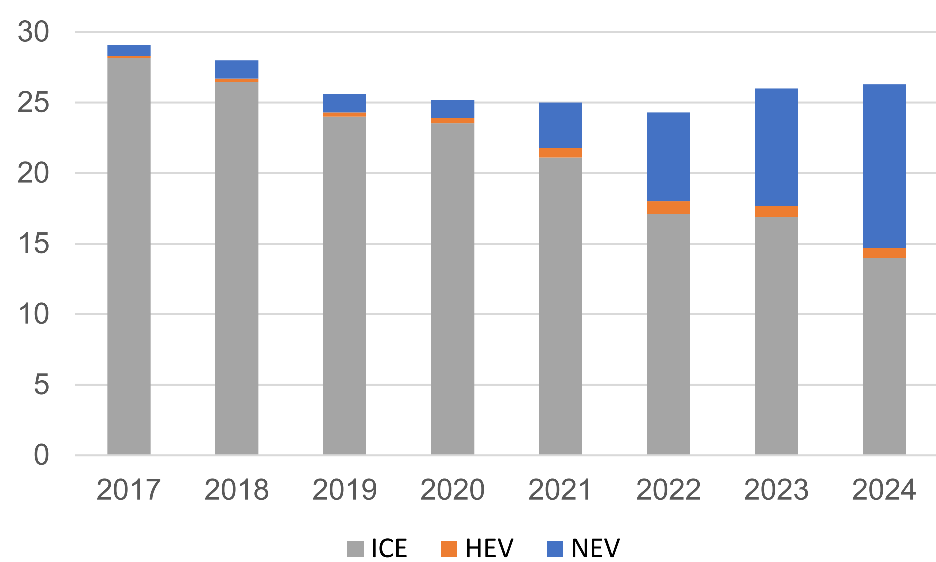
Q3. What drove China's automotive recovery and rise to global leadership?

A relevant driver of China's car market recovery is a low ownership per capita which– at roughly 160 vehicles per 1,000 inhabitants in 2019, rising to 220 by 2024 – remained well below European and US levels (about 564 and 860 cars per 1,000 inhabitants, respectively). This means that demand growth still had an incremental, new-buyer component alongside replacement.

A key driver of the recovery, however, has been the rapid expansion of China's domestic EV sales starting from 2020 (Figure 3). Generous subsidies and regulatory waivers for Chinese consumers buying electric cars have played a significant role in jump-starting the market (Bickenbach et al. 2024). The industry has moved swiftly to accommodate the booming demand for EV increasing production capacity on the back of massive financial support provided by local and central governments which took the form of concessional land, subsidized inputs and preferential credit policies. The objective was not merely to sustain sales but to build a globally competitive domestic industry, first in conventional vehicles and then, decisively, in electric ones. The specific instruments through which this strategy was executed in the EV segment are examined in Q4.

Figure 3: Vehicle sales by powertrain in China

(*million vehicles*)



Source: Authors' computation on CAAM and GACC data. New energy vehicles (NEVs) include EVs and FCEVs.

Besides government intervention, the Chinese domestic industry entered the post-pandemic period unburdened by the legacy constraints that weighed on Western OEMs: Chinese automakers had been built from scratch with state backing since the early 2000s, carried no sunk costs in ICE technology and faced no shareholder pressure to defend combustion-engine profit streams. These structural advantages helped China return automotive sales above pre-pandemic levels much faster than other major economies, laying the foundations for the country's emergence as the world's largest vehicle market and exporter (Figure 3).

II. Electrification and Industry Transformation

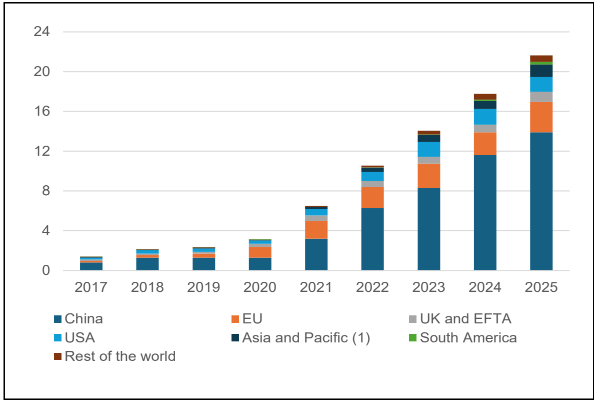
Q4. How did China electrify so rapidly?

Electric vehicle sales in China took off in the post-pandemic period. Yearly EV sales were around 14 million units in 2025, up from close to 1.3 million in 2020, about half of all new vehicles sold, a remarkable rise from approximately 5% just five years earlier. With world sales of electric vehicles close to 22 million in 2025, China accounted for two-thirds of the global market and its penetration rate was by far the highest among major economies (Figure 4, Panels a and b).[6] The domestic success has also fed a rapid expansion into export markets, transforming China into the world's largest vehicle exporter by 2025 – a development examined in Section III.

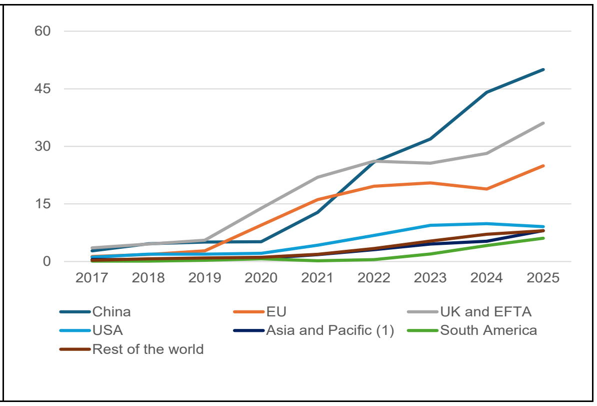
Figure 4: Global sales of electric vehicles (EV)

(*annual data*)

(a) sales by market (*million vehicles*)



(b) EV share of new vehicles by market (*percentages*)



Source: Authors' computations on national data. (1) Excluding China.

[6] China is expected to push the share of EV in total vehicle stock to 50% by as 2040 (Bencivelli *et al.*, 2025).

China's rapid electrification reflects a combination of industrial strategy, structural conditions and first-mover advantages that established Western, Korean and Japanese OEMs have struggled to replicate (Yang, 2023). As noted in Q3, the absence of sunk costs in ICE technology, legacy supply chains and combustion-related profit expectations allowed domestic firms to pivot toward BEVs with a strategic agility beyond the reach of traditional automakers whose business models depended on continued ICE monetization.

The role of the State was central and multi-layered. Beginning with the 2001-2005 Tenth Five-Year Plan, EV technology was designated a national research priority and supported through sustained public funding, well before commercial viability was in sight. Supply-side incentives – including concessional land, preferential loans, direct cash transfers and low-cost electricity –reduced costs across the value chain. The 2017 "*dual-credit policy*" reinforced this shift by requiring automakers to meet fleet average fuel-economy targets while accumulating a minimum quota of new-energy-vehicle credits, effectively compelling industry-wide electrification rather than leaving it solely to market forces[7].

Demand-side policies reinforced these incentives. In several large cities, restrictions on ICE vehicle registrations and the high cost of license plates (at times exceeding $12,000) made EVs economically attractive even before purchase subsidies were considered.

A decisive structural advantage lies in China's dominance over battery technology, which accounts for roughly 40% of BEV value added. By controlling the supply chain from raw materials to pack assembly, Chinese firms internalized margins that foreign OEMs ceded to external suppliers. This advantage is not purely financial: early mastery of battery chemistry, manufacturing processes and scale-driven learning curves has positioned Chinese firms at the core of the BEV technological regime. EU-based battery production remains substantially more expensive than Chinese equivalents (up to 45%), a cost differential that tariffs can only partly offset and that continues to underpin the global competitiveness of Chinese manufacturers (Whitfield and Wuttke, 2026; IEA, 2025b).

Q5. Why is progress in electric mobility slower outside China?

Outside China, the transition to electric mobility has proceeded much more slowly. Among advanced economies, EVs accounted for nearly 25% of new vehicle sales in the EU in 2025 and 36% in the United Kingdom and EFTA countries, while penetration remained considerably lower in the United States, Japan and several emerging markets.

[7] The *Measures for the Parallel Administration of Corporate Average Fuel Consumption* (CAFC) and New Energy Vehicle (NEV) Credits pushed automakers toward electrification by requiring them to meet fuel-consumption and EV production targets – or buy credits from firms with surpluses – creating a quasi-mandatory EV quota system.

In the EU, EV adoption has been constrained by high purchase prices,[8] a limited supply of affordable models (IEA, 2025)[9] and uneven charging infrastructure.[10] Although charging networks have expanded, coverage remains fragmented across member states and public charging costs often reduce the economic advantage of EV ownership (IEA, 2026). Persistent consumer concerns over driving range and policy uncertainty have also weighed on demand:[11] frequent changes to subsidy schemes and ongoing debate over the timing and scope of the 2035 phase-out of new ICE vehicle sales have complicated investment and purchasing decisions.[12]

In the United States the transition has progressed even more slowly. EVs represented about 9% of vehicle sales in 2025, reflecting persistent affordability[13] and charging constraints, particularly outside major urban areas (NADA, 2025b; Argonne National Laboratory, 2026)[14,15]. As a result, hybrids have emerged as the preferred transitional technology. The rollback of key Biden-era decarbonization measures in 2025 further slowed EV adoption and reinforced perceptions that the transition remains heavily dependent on policy support.

Japan's low EV penetration (around 2% of vehicle sales) reflects a technology-neutral policy framework that – combined with a relatively slow expansion of charging infrastructure – has favored hybrids over fully electric vehicles. By contrast, South Korea has pursued a more

[8] According to the 2025 EAFO consumer monitor survey, high purchase price is by far the main barrier to BEV's adoption, followed by range concerns and charging convenience (EAFO, 2026).

[9] Carmakers' focus on high-profit-margin models has led to stagnating EV price premiums over ICEs (IEA, 2025). According to T&E the shift toward larger vehicles is the main contributor to high average BEV price since 2020. The BEV's market is more skewed towards higher segments and SUVs than the ICEs (T&E, 2026).

[10] By the end of 2025, the EU had more than 1 million public charging points, over six times the 2020 level, but deployment is still very uneven: the Netherlands, France and Germany together account for about 55% of all EU chargers, while numerous member states remain in early-stage rollout, and most charging points are concentrated in urban areas.

[11] In 2024, the reduction or withdrawal of financial incentives for EV purchases in key EU markets contributed to an outright contraction in sales across the bloc. The effect was most acute in Germany, where subsidies were abruptly terminated in December 2023, driving a 27% fall in domestic BEV registrations in the following year (EAFO, 2024).

[12] Among respondents to the July 2025 ECB CES who were planning to purchase a car, 42% indicated a preference for an ICE vehicle and 41% for a hybrid (HEV and PHEV), while only 16% intended to buy a BEV (ECB, 2025). A similar pattern emerges in consumer surveys by EAFO (2026).

[13] Market analysists report an EV average transaction price of approximately $54,900 in March 2026, compared to an industry average of $49,275 (Cox Automotive, 2026b).

[14] According to a recent survey by the Pew Research Center (2026), only 32% of Americans said they would seriously consider buying a fully battery-electric vehicle as their next vehicle, with notably lower interest in rural areas compared to urban and suburban residents. This urban-rural gap is very likely related to persistent charging-access disparities: while 60% of urban residents live within a mile of a public charger, only 17% of rural Americans do, a condition that still sustains widespread range anxiety outside the main urban centers.

[15] Public charging points were almost 250,000 by April 2026 and were heavily concentrated in urban areas: 4-6% of public charging points were located along highways and at end-2024 only 35% of the Interstate highway system had chargers spaced within 50 miles (with the central US lagging at 20–30% corridor coverage).

proactive electrification strategy. Supported by the vertically integrated Hyundai-Kia ecosystem and close coordination with domestic battery and electronics producers – like Samsung, LG Energy Solution and SK On – EVs accounted for around 14% of vehicle sales in 2025.

Q6. How has the shift to electrification altered the competitive calculus for traditional car makers?

The shift to EVs has fundamentally reshuffled competitive advantages across the global automotive industry. Electrification requires entirely new capabilities in batteries, software and electronic architectures that do not build directly on the accumulated expertise associated with ICEs.

For established *Original Equipment Manufacturers* (OEM), the transition is costly and complex. Legacy manufacturers have faced a three-way challenge: funding dedicated EV platforms while remaining dependent on ICE profits, sustaining parallel ICE and EV product lines, and developing software-defined vehicle capabilities largely absent from traditional automotive engineering (Draghi, 2024). No European OEM has solved all three simultaneously. Several European manufacturers have responded through partnerships with Chinese firms aimed at gaining access to technology, reducing costs and accelerating product development.[16]

European OEMs have increasingly relied on a "*powertrain hedge*" strategy – maintaining ICE and hybrid production lines alongside nascent EV programs – that reflects both a mismatch between consumer preferences and regulatory timelines and the practical impossibility of committing exclusively to battery-electric before infrastructure, affordability and demand are ready. The resulting emphasis on value over volume has supported profitability in the short term. European carmakers posted record profits in 2022-2023 while selling on average roughly 25% fewer vehicles than before the pandemic (Figure 5). However, this strategy eroded their competitive position in China and elsewhere, leaving a gap in entry-level and mid-market segments that Chinese manufacturers are increasingly filling.[17]

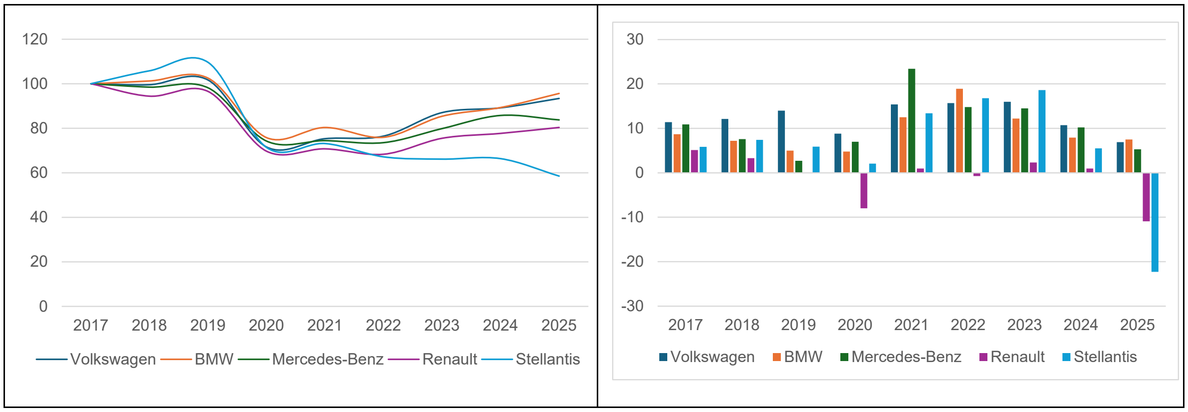
[16] Volkswagen extended its joint venture with SAIC until 2040. Stellantis acquired an equity stake in Leapmotor and established a joint venture for selling and manufacturing Leapmotor products outside China. Renault established a joint venture with Geely in 2024 initially focused on hybrid and combustion powertrains, subsequently expanded to electrification.

[17] In 2025 Chinese brands accounted for about 6% of the European passenger car market (8.2% including Volvo, which is controlled by a Chinese group); in the BEV segment the share was 11.5% (15.5% with Volvo; Inovev, 2026).

Figure 5: European *Original Equipment Manufacturers* (OEM) sales and profits
(*annual data*)

(a) car sales in the European market (1) (*car registrations index, 2017=100*)

(b) net profits (*euro billion*)



Source: Authors' computations on ACEA and company data. (1) Includes sales in the EU, UK and EFTA.

The combined global BEV share across the five main European automotive groups (Volkswagen, Stellantis, Renault, BMW, Mercedes-Benz) was around 8% in 2025 (or 13% including PHEV). Hybrid is doing the heavier lifting in the near term, with a share that reached approximately 17% in 2025. Even the geographic diversification that once cushioned European OEMs against domestic demand cycles has become a source of structural earnings pressure.[18] As powertrain preferences fragment across regions (see Appendix A) – BEVs and PHEVs dominant in China, ICEs and hybrids in the United States – maintaining competitive product portfolios in each market simultaneously has become less sustainable.[19]

European manufacturers also face structural disadvantages relative to Chinese and South Korean competitors, including limited vertical integration in battery supply chains; manufacturing footprints in Germany, France and Italy carrying cost structures that leave little room to compete on price; and a historically weak software engineering base, ill-suited to the speed and iterative cycles of digital product development (Draghi, 2024). At the same time, the erosion of their historical competitive position in China has reduced an important source of profitability and scale.

[18] China illustrates the problem most acutely. European brands built their profit architecture around the premium segment there, with Volkswagen, BMW, and Mercedes collectively deriving around 25-30% of global revenues from China at peak. That position is eroding rapidly as Chinese brands have moved upmarket aggressively, offering software-rich EVs at prices European OEMs cannot match.

[19] Stellantis closed 2025 with a net loss of €22.3 billion, largely attributable to €25.4 billion in exceptional charges that management described as the cost of having overestimated the pace of the energy transition and the need to reset its product portfolio around customer powertrain choice. Losses were amplified by a deeper inventory and pricing reset in North America and a wider multi-market footprint spanning regions with sharply divergent powertrain preferences.

Japanese carmakers – particularly Toyota and Honda – have leveraged their global leadership in hybrid technology as a defensive advantage, although they risk lagging in full battery-electric and software-defined vehicles. Toyota's BEV share stood at only about 2% of global sales in 2025, rising to around 3.6% including PHEVs, and its progress on software-defined vehicle platforms has been notably slow.

South Korean Hyundai-Kia has navigated the transition most effectively among legacy producers through a deliberate decision to avoid the Chinese market and concentrate on the EU and US, combined with a dual-track strategy of simultaneously investing in BEVs (about 7% of group total sales) and hybrids, where they gained significant market share.

III. Geopolitics, Trade Wars and Industrial Policy

Q7. How has global automotive trade been reshaped, and what new patterns are emerging?

The post-pandemic period has witnessed a fundamental reordering of global automotive trade that represents the most dramatic shift in the industry's geography in decades.

China's emergence as the world's leading car exporter is the defining development. Chinese passenger car exports stood at almost 0.9 million units in 2019; by 2025, they were over 7 million units, overtaking the EU to become the world's largest exporter by volume. This surge was sustained by the transition to EVs – accounting for about 50% of Chinese passenger car exports in 2025 (Figure 6, Panel a).

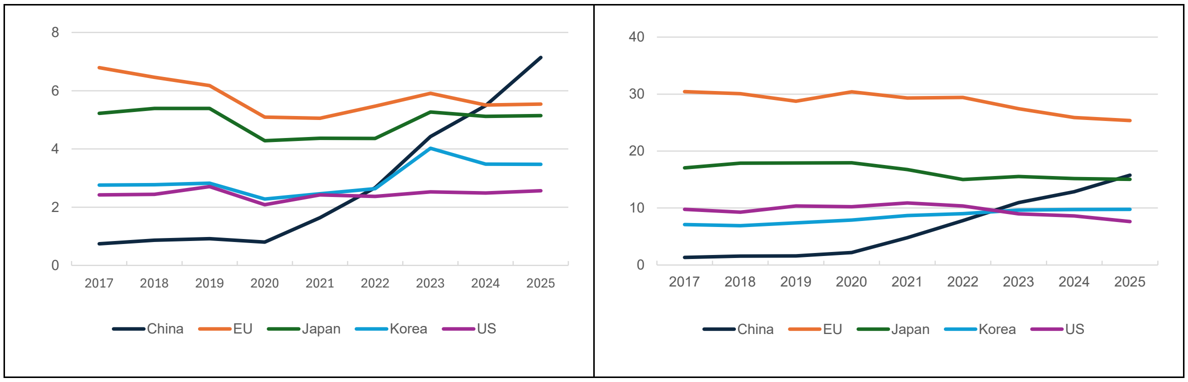
By contrast, EU car exports lost volume and market share (Figure 6 Panel b). The fall of ICE shipments was partially offset by rising HEV and BEV exports, but overall volumes declined by roughly 0.6 million units in the post-pandemic period. EU value market share held up initially due to higher unit prices and a compositional shift toward premium models, but this advantage has been eroding since 2022 as Chinese competition intensified.

Japan and South Korea followed divergent paths. Japan's exports barely recovered to pre-pandemic levels of around 5 million units, reflecting its large exposure to the Chinese market and slow BEV adoption. South Korea's exports expanded strongly, reaching around 3.5 million export units in 2025, primarily to North America and Europe.

Figure 6: World exports of passenger cars

(annual data)

(a) exports by country of origin (*million vehicles*) | (b) market shares by country (1) (*shares of world exports of passenger car*)



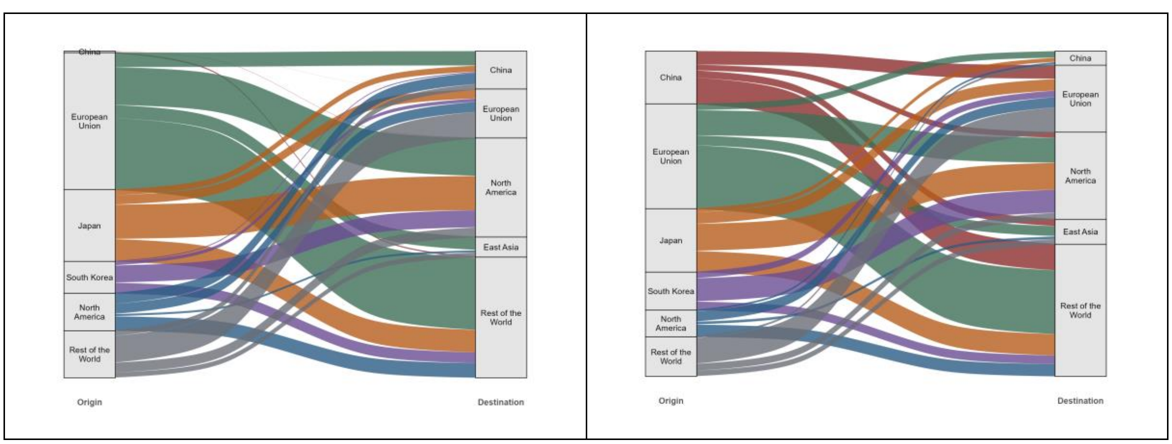
Source: Authors' computations on Trade Data Monitor, China Custom and Eurostat. (1) Market share of total world exports of passenger cars in value terms excluding intra-EU trade.

Within a decade, automobile trade has shifted from a relatively balanced multipolar structure, with the EU, Japan, South Korea, and North America each commanding significant export shares across major destination markets, to one where China has abruptly emerged as a large car exporter (Figure 7). This shift reflects intensifying competitive pressure from Chinese OEMs and has affected all major destination markets, eroding market shares of all traditional exporters, most sharply those from the EU.

Figure 7: World export flows of passenger cars

(annual data)

(a) 2015 *(shares and thousands USD)* | (b) 2025 *(shares and thousands USD)*



Source: Authors' computations on Trade Data Monitor.

Q8. How are China EV exports changing, and which markets are being reached?

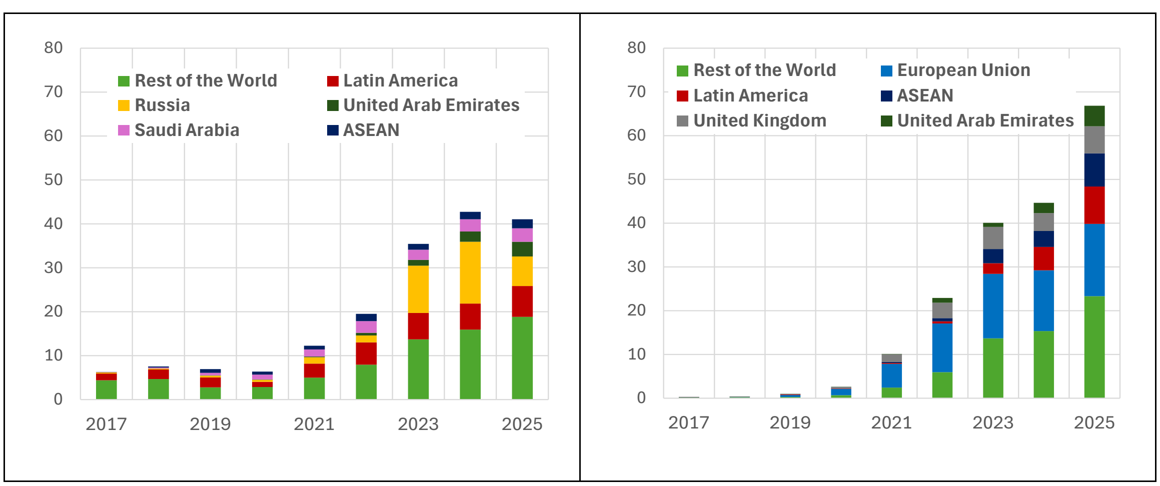
Within China's overall export surge, the EV component deserves separate attention: it is where competitive pressure on incumbent producers is most acute and where the policy response of destination markets has been sharpest. While ICE shipments have also grown rapidly – directed predominantly toward Russia, partly filling the vacuum left by Western brands following the 2022 sanctions – the structural driver of China's export ascent is the degree of electrification achieved in foreign markets (Figure 8).

Chinese EV exports display strong market segmentation across destination regions. Advanced economies have been the primary targets for battery electric and plug-in hybrid vehicles: EU imports from China stood at around 600,000 electric cars in 2025, with the share of Chinese OEMs in those imports representing more than 70%, up from 50% in 2023 (IEA, 2026).

In parallel, emerging markets have become as a significant new frontier. In Southeast Asia, Thailand has become a gateway for Chinese EV manufacturers seeking access to the broader ASEAN market, leveraging tax concessions and investment agreements; Chinese brands including BYD and Great Wall now account for 70–80% of EV imports. Latin America has followed a similar trajectory, with Chinese OEMs capturing dominant shares of EV sales in Brazil and Mexico. The large gap in export unit values between Europe and Southeast Asia is consistent with differentiated market positioning across destination regions, with Chinese OEMs competing in higher-value segments in advanced economies while pursuing scale expansion through lower-cost models in emerging markets (IEA 2026).

Figure 8: China's car exports value by destination

(a) Internal Combustion Engine *(USD billion)* | (b) Electric and Hybrid *(USD billion)*

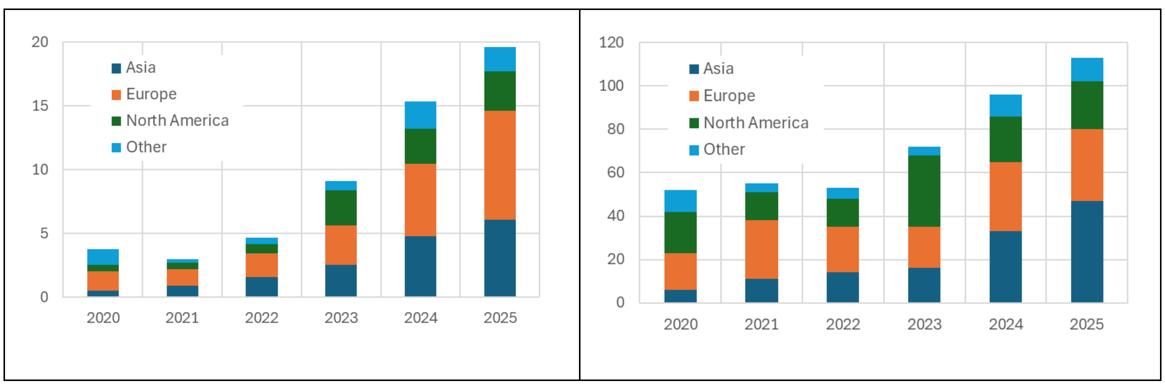


Source: Authors' computations on Trade Data Monitor.

The brand composition of Chinese EV exports has also shifted materially. Until 2023, foreign brands – particularly Tesla from its Shanghai Gigafactory – accounted for the largest share of China-origin EV shipments. By 2024, Chinese OEMs accounted for 70% of total EV exports from China, up from 55% in 2023, marking the definitive transition from JV-led to indigenous-brand export growth. By 2024, Chery led overall vehicle exports, followed by BYD, SAIC, Geely, and Great Wall Motor. Looking ahead, the primary threat to continued export growth to advanced markets is rising tariffs and non-tariff trade barriers. Emerging markets present a more varied picture, with Brazil and several Southeast Asian economies considering or implementing protective measures. Chinese OEMs have responded by accelerating localization, treating regulatory pressure as an incentive to embed themselves more deeply in target markets, with plants now operational or under construction in Southeast Asia and Latin America (Figure 9). EU-specific localization responses are examined in Q10.

Figure 9: China's automotive direct investments by destination

(a) Value *(USD bn)* (b) Number of units



Source: Authors' computations on China Cross-border Monitor data (Rhodium).

Q9. How did the US and the EU react to China's emergence as EV global leader?

United States

The US government was the first to frame unconstrained Chinese EV exports – backed by what it deemed unfair large state subsidies and excess production capacity – as a systemic threat to its domestic auto industry and to national security in the transition to electrification. This concern has driven a policy mix of tariff barriers and targeted industrial measures that have evolved from trade remedies into a comprehensive defensive regime, combining prohibitive tariffs, national security instruments, and ICT and data-governance restrictions.

A pivotal shift occurred in 2024, when the Biden administration – at the conclusion of a statutory review of Section 301 tariffs imposed in 2018 – raised the additional duty on Chinese-made EVs from 25% to 100%, and on lithium-ion EV batteries from 7.5% to 25%. Duties on selected battery parts, critical minerals and upstream inputs were tightened as well.

These measures were explicitly framed as necessary to prevent Chinese overcapacity undercutting the domestic EV and battery manufacturing capacity catalyzed by the *Inflation Reduction Act* (IRA).

Beyond price-based barriers, the US government introduced a second layer of defense through connected-vehicle data governance. The Commerce Department's Bureau of Industry and Security (BIS) published the *Connected Vehicles Final Rule* in January 2025, prohibiting the import or sale of connected vehicles incorporating hardware or software with a sufficient nexus to China or Russia.[20]

These China-specific measures set the template for the broader tariff regime that followed under the Trump administration, examined in Q11.

EU

In the European Union, the Commission opened a countervailing duty investigation in October 2023 and published its findings in June 2024. The investigation concluded that Chinese EV producers had received subsidies in the form of direct cash transfers, preferential loans, free or discounted land, and demand-side support between 2016 and 2022. In October 2024, the Commission imposed definitive countervailing duties ranging from 17.4% for BYD (the most cooperative producer) to 35.3% for SAIC (the least cooperative), on top of the existing 10% MFN tariff. Tesla's Shanghai operations received a rate of 7.8%, reflecting lower subsidy benefit and partial cooperation. The measures were approved by a slim majority in the EU Council, with Germany – whose carmakers have substantial exposure in China – notably voting against.

By mid-April 2025, the EU and China had agreed to explore a minimum-price mechanism as an alternative to the countervailing tariffs. In January 2026, the Commission published formal guidance allowing Chinese exporters to submit price undertaking offers, under which a manufacturer committing to sell above a defined minimum import price would be exempt from countervailing duties [21]. The standard 10% import duty that applies to all cars entering the EU continues to apply regardless; only the additional countervailing duty – the penalty specifically targeting Chinese subsidies – is waived.

[20] The rule targets Vehicle Connectivity Systems – including Bluetooth, cellular and satellite modules – and Automated Driving Systems. It phases in software-related prohibitions from model year 2027 and hardware-related prohibitions from model year 2030.

[21] The first such undertaking was accepted in February 2026 for the Cupra Tavascan – produced in China by Volkswagen's joint venture Volkswagen (Anhui) Automotive Company Ltd. – with approval conditioned on compliance with volume caps and verifiable EU investment commitments.

The Commission is now reported to be considering whether to extend trade defense measures to hybrids, a step that would substantially broaden the scope of the EU's response to Chinese automotive competition.

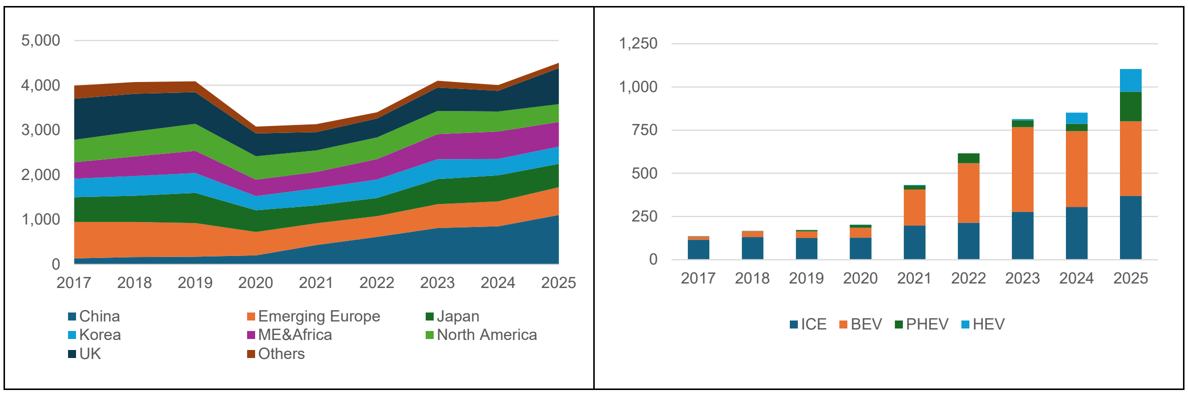
Q10. How did Chinese OEMs respond to EU countervailing tariffs?

Along with the legal actions filed before the European Union Court of Justice and the WTO,[22] Chinese OEMs have responded to EU defensive measures through a combination of powertrain switching, price adjustment and investments to consolidate their footprint in European markets.

Figure 10: EU passenger car imports

(*annual data, thousand vehicles*)

(a) imports by partner (b) imports from China by powertrain



Source: Authors' computations on Eurostat.

EU countervailing tariffs have not dented imports of Chinese passenger cars, which reached 1.1 million units in 2025 – nearly 30% higher than in 2024 – accounting for approximately one quarter of total car imports into the Union (Figure 10, Panel a). BEVs – the targets of the defensive measure – were only marginally affected, with imports declining by just 1.8% (to about 430,000 units), while imports of hybrid powertrains (PHEVs and HEVs) almost doubled and ICE vehicle imports also rose (Figure 10, Panel b). In value terms, imports of Chinese cars grew by only 4.3%, reflecting a volume-for-value strategy adopted by Chinese carmakers, with BEV import unit values falling sharply (by about 27%), largely offsetting the higher tariff burden.

The limited decline in BEV sales suggests that EU demand for Chinese electric vehicles remains broadly stable. By contrast, the sharp expansion of hybrid vehicle sales points to the

[22] In January 2025, Chinese EV manufacturers including BYD, Geely and SAIC filed lawsuits in the Court of Justice of the European Union (CJEU) to challenge the definitive tariffs. On 6 November 2024, China also initiated a formal dispute at the WTO regarding the countervailing duties (WTO, 2024).

emergence of a new market segment that Chinese manufacturers are actively and successfully targeting. Overall, these trends appear only marginally influenced by the current tariff regime and reveal an additional source of competitive pressure for the European automotive industry, particularly in a segment where EU OEMs, alongside Japanese and South Korean producers, have traditionally held a strong position. Looking forward, PHEV exports are now approaching the volumes that triggered the original BEV investigation, raising the prospect of additional trade defense action (Williams 2026).

Over the past two years, Chinese OEMs have continued to advance selectively with the establishment of manufacturing capacity in the EU, but the momentum behind large-scale localization has weakened.

BYD remains the most significant case – with an independent production facility operating in Hungary and one under development in Turkey –, while Chery has pursued a lower-commitment entry strategy through a partnership with Spain's EV Motors to assemble vehicles in Barcelona under the revived Ebro brand. Leapmotor, for its part, has relied on production-sharing arrangements with Stellantis, assembling vehicles in Poland and planning limited additional output in Spain. While China Cross-Border Monitor data by Rhodium Group [23] still record sizeable Chinese automotive FDI inflows into Europe – disproportionately benefiting Hungary and other Central and Eastern European countries –, these figures are driven by a small number of flagship or legacy projects.

Where local production has materialized, Chinese firms have so far relied heavily on imported inputs, including batteries, powertrains, and steel, resulting in limited domestic value added. This has reinforced European policymakers' concerns that Chinese localization patterns may do little to strengthen EU automotive supply chains and could instead entrench structural dependencies, constraining the development of indigenous manufacturing capabilities.

Q11. What has been the impact of 2025 Trump tariffs on the American automotive market and its supply chains?

While Q9 traced the US defensive measures specifically targeting Chinese EVs, the Trump administration's 2025 tariff offensive went considerably further, hitting all imported vehicles regardless of origin. Following its January 2025 inauguration, the Trump administration invoked Section 232 of the Trade Expansion Act of 1962 to impose a 25% tariff on all imported passenger vehicles and specified auto parts – engines, transmissions, powertrain and electrical components –, citing persistent national-security risks from import

[23] Data available at *China Cross-Border Monitor*.

dependence. USMCA-compliant parts received a temporary exemption, later to be narrowed to US-origin content only.

The Trump administration's tariff offensive has had multi-layered effects on the US automotive market, producing short-term demand distortions, medium-term cost inflation and a deeper reconfiguration of North American supply chains.

On the demand side, tariff announcements triggered substantial front-loading behavior, as households accelerated purchases ahead of the tariffs taking effect in early April. This surge redistributed demand over time rather than creating durable market expansion, while market analysts warned that tighter supply and higher prices would weigh on sales later in the year.

On the cost side, the tariff shock has been significant. The 25% duties on automobiles and many auto parts were layered on top of broader trade restrictions on steel and aluminum, raising costs across the value chain. Analysts estimated that the new vehicle tariffs alone could lift prices anywhere between $4,000 and $15,000 per vehicle, depending on import content and supply-chain exposure. Manufacturers initially absorbed part of the shock, which helped limit the immediate pass-through to consumers: average transaction prices increased only modestly in late 2025 despite tariff pressure, suggesting that OEMs and dealers were temporarily cushioning the impact through incentives, margin compression and selective pricing strategies. Even so, the tariff regime reinforced broader affordability problems and supported a shift toward the used-vehicle market, contributing to renewed strength in prices.

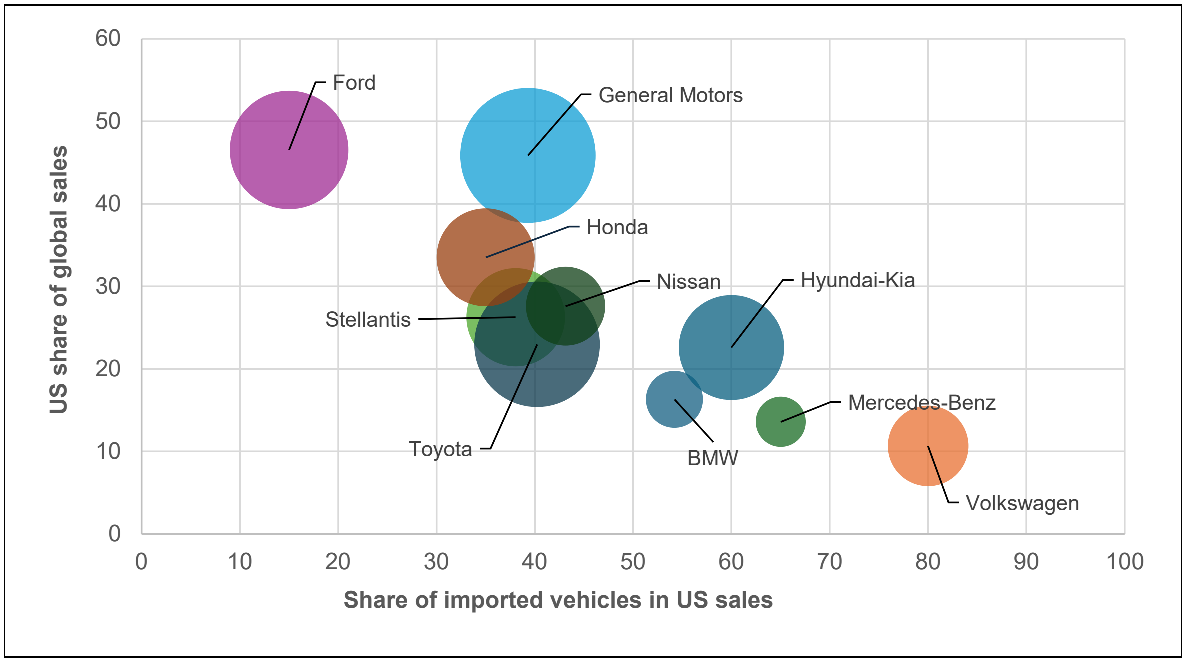
The supply-chain implications have been equally important. Section 232 tariffs were designed to promote reshoring, but in practice they have put pressure on the deeply integrated North American production model by forcing firms to reassess sourcing, local content and assembly footprints under USMCA rules. As a result, the likely outcome is not a clean return to national production, but a more fragmented and costly form of regionalization.

The Trump tariffs on imported vehicles and components have created a structural cost disadvantage for foreign automakers that cannot be resolved quickly. For European, Japanese and Korean OEMs, the challenge is threefold: a large share of their US sales depends on vehicles assembled abroad, the US market is too important to exit or meaningfully scale back, and the only durable solution – relocating production to American soil – requires multi-billion-dollar investments and years of lead time. The effective tariff burden may fall unevenly on OEMs, depending on the origin mix of not only the final product but also of the components used in production in the US.

Korean OEMs face the most acute pressure, with Hyundai and Kia importing roughly 60% of their US sales from South Korea while the US accounts for nearly a quarter of their global volumes (Figure 11).[24]

Figure 11: OEMs' tariff exposure

(*2024 data; percentages*)



Source: Authors' computations on company data. Note – The horizontal axis reports for each OEM the percentage ratio of finished vehicles imported into the United States to the automaker's total US vehicle sales. The vertical axis shows the weight of the US market on OEM's worldwide sales. Bubble area is proportional to the automaker's total US vehicle sales in 2024 (larger circles denote larger American market footprints).

Japanese OEMs are partially shielded by a bilateral framework agreement announced in July 2025 and implemented in September, reducing tariffs on Japan-origin vehicles to 15%. Honda and Nissan – with roughly 35% and 43% of US sales imported respectively – still face a direct margin squeeze that their more limited global scale amplifies. Toyota, despite its size, bears the largest absolute cost of any OEM globally: the company projected a tariff impact of $9.4 billion for its fiscal year ending March 2026, a figure that already incorporates partial relief from the September rate reduction.[25]

[24] The tariff trajectory has been particularly volatile for Korean OEMs: the original 25% tariff was temporarily reduced to 15% under a bilateral agreement effective November 2025, only to revert to 25% in January 2026 after South Korea's National Assembly failed to ratify the deal. This leaves Korean-origin vehicles facing a 10-percentage-point cost disadvantage relative to Japanese competitors, who benefit from the 15% rate negotiated under the U.S.–Japan bilateral agreement.

[25] On a full-year outturn basis, US tariffs erased all of Toyota's North American operating profit, resulting in a rare operating loss of $1.9 billion for the region.

European OEMs are the most import-dependent in proportional terms – Volkswagen imports about 80% of its US sales, Mercedes-Benz 65%, BMW 55% – but since the US represents only 10–20% of their global volumes the threat is primarily one of competitiveness and margin erosion in the premium segments that matter most to their profitability. Stellantis benefits from a broad North American manufacturing base but remains exposed through its reliance on Mexican and Canadian supply chains, with roughly 40% of North American shipments crossing a border before reaching the customer.

IV. Supply Chains, Critical Minerals and Resilience

Q12. Why have critical minerals and battery supply chains become a strategic battleground?

The shift from combustion to electric powertrains has fundamentally redrawn the map of competitive advantage in the automotive industry. An EV requires roughly six times more mineral input than a conventional vehicle, and battery systems alone account for approximately 40% of total BEV manufacturing cost, drawing on lithium, cobalt, nickel, manganese, graphite and copper at an unprecedented scale. As a result, battery supply chains have become a central issue not only of industrial competitiveness, but also of economic security and geopolitical influence.

Through state-directed investments, bilateral agreements and sustained industrial policy support, Chinese entities secured dominant positions across the entire lithium-ion battery value chain including extraction, refining, cell manufacturing and pack assembly. Chinese entities refine approximately 60% of global lithium, 70% of cobalt and over 90% of battery-grade graphite, while CATL alone controls around 35% of global cell production capacity and is targeting commercialization of sulfide-based all-solid-state batteries by 2027. China's lithium battery sector is characterized by a persistent and sizeable overcapacity which exceeds global demand by a wide margin. This structural surplus has the effect of suppressing global prices, discouraging rival investment, and reinforcing China's cost leadership across lithium-ion battery value chains (McKinsey & Co. 2025). Control over the entire supply chain now confers structural cost and technology advantages that downstream manufacturing excellence can hardly offset (IEA, 2024). The current reconfiguration of global competition suggests that China's cost advantage is likely to persist over the medium term.

Advanced economies have sought to reduce dependence on Chinese-dominated battery supply chains, though through different policy instruments. Japan has used the Green Innovation Fund to support next-generation battery technologies, while South Korea has pursued battery competitiveness and supply-chain stabilization programs. The EU has placed greater emphasis on critical raw materials and domestic battery production through its Critical Raw Materials strategy and the European Battery Alliance. Nevertheless, European cell manufacturing costs remain significantly higher than China's, where BEVs have now reached price parity with ICE vehicles across almost all segments (IEA, 2026).[26] The expansion of Chinese battery manufacturers into Europe – CATL is building gigafactories in Hungary and Germany – increases domestic cell production capacity without reducing strategic dependency: technology, intellectual property and key upstream inputs remain heavily dependent on Chinese firms. European-owned cell production capacity now accounts for only 30% of the continent's 2030 pipeline, a share further eroded by the bankruptcy of Northvolt in March 2025 and the suspension of ACC's planned facilities in Germany and Italy in early 2026.

V. Technology, Software and the Software-Defined Vehicle

Q13. What is the software-defined vehicle, and why does it represent a competitive inflection point?

The software-defined vehicle (SDV) represents a fundamental architectural reinvention of the automobile: a shift from a product defined primarily by mechanical hardware – engine, transmission, body – to one whose capabilities, value proposition and competitive differentiation are determined predominantly by software, data, and digital services.

In an SDV, vehicle features are not fixed at the point of manufacture but evolve continuously through over-the-air software updates, enabling carmakers to add functionality, improve performance, and monetize the vehicle relationship throughout its lifecycle rather than at the point of sale. This model creates new revenue streams through subscriptions, in-vehicle services, autonomous driving features, connectivity packages and vehicle-to-grid interactions, fundamentally changing the economics of the automotive business.

The SDV transition constitutes a competitive inflection point for three interconnected reasons. First, it shifts the locus of value creation from domains where incumbent OEMs hold established advantages – precision manufacturing, powertrain engineering, supply chain management – to domains where technology-native entrants are structurally stronger: software architecture, AI integration, and platform ecosystems. Innovations that destroy

[26] Cell production costs in the EU are approximately 56% higher than average Chinese pack prices, currently at around \$84/kWh in 2025 (McKerracher, 2025). BYD has further pushed the costs of premium battery pack below \$50/kWh through vertical integration and scale, a benchmark entirely out of reach for any European producer today.

rather than build on existing competences tend to favor new entrants over incumbents, and the SDV fits this pattern precisely (Tushman and Anderson, 1986).

Second, the shift to software-enabled services rewrites industry economics: over-the-air updates, subscription features, and data monetization create recurring revenue streams that reward firms with large, connected fleets and deep software stacks over those with superior manufacturing efficiency.

Third, SDV capabilities compound non-linearly – training data, driver assistance performance, and user behavioral data reinforce one another through machine learning feedback loops, generating winner-takes-most dynamics more typical of digital platform markets than of the fragmented competition that characterized the ICE era. For established carmakers, the challenge is therefore not merely technical catch-up but organizational transformation, at a pace dictated by competitors who started without legacy constraints.

The transition to SDVs also accelerates the convergence between automotive manufacturing and the technology sector. Chinese manufacturers have advanced rapidly in SDVs by tightly integrating software development with the domestic tech ecosystem. BYD's "*God's Eyes*" advanced driver-assistance system, developed with AI capabilities including *DeepSeek* language-model integration, was released in early 2025 and is now a standard feature across all BYD models. BYD reported spending USD 4.6 billion on intelligent driving R&D in just the first three quarters of 2024. Chinese carmakers are assessed to be two to three years ahead of Japanese competitors on SDV development cycles.

Korean OEMs have pursued a globally collaborative SDV model, leveraging partnerships with Samsung, LG and SK to deliver competitive platforms. Their adoption of open-platform approaches and software development kits has positioned Hyundai and Kia well for the SDV era, though still short of the “software-first” Chinese approach.

Japanese manufacturers have historically struggled with the SDV transition, reflecting deep hardware-first engineering cultures. Toyota's internal inertia on digital transformation has been well documented, while a consortium of Japanese OEMs and suppliers established in December 2023 – targeting next-generation automotive semiconductor architecture by 2029 – illustrates both the seriousness of the challenge and the ambition to close the gap.

European manufacturers lag furthest behind on the SDV transition. Several have pursued partnerships with Chinese firms or technology players – Volkswagen through its CARIAD software unit and tie-ups with Chinese tech firms, Stellantis through its Leapmotor stake, Renault through its collaboration with Geely – as a faster route to software capability than internal development alone could deliver in time.

Q14. What data governance and cybersecurity challenges arise from the proliferation of connected vehicles?

The increasing connectivity of electric and software-defined vehicles generates enormous volumes of personal data – on location, driving behavior, biometric interactions, communication patterns and proximity to infrastructure – that have significant commercial, privacy and national-security implications (Borgogno and Veronese, 2026).

For Chinese connected vehicles operating in Western markets, the core concern is that Chinese law – specifically the Cybersecurity Law and associated regulations – mandates that Chinese companies maintain control over data and surrender it to the Chinese government on demand, even when the data relates to citizens or activities in foreign jurisdictions. This creates an inherent conflict with the EU's GDPR and with US privacy and national security frameworks. AI systems such as DeepSeek, integrated as standard features in BYD and Geely vehicles, have access to vast data streams from vehicles operating globally, building comprehensive profiles that could encompass location, routine, identity and even health information.

In the United States, the governance of connected-vehicle data has increasingly been treated not only as a privacy issue, but mainly as a matter of national security and market access (see Q9 for details).

The EU Commission has cited data governance as one of the strategic dimensions of the EV tariff and investment screening framework.

China has attempted to address these concerns domestically through regulations such as the "In-vehicle processing principle" (data should not leave the vehicle) and the "Principle of non-collection by default", but Western authorities have remained skeptical of the practical effectiveness of these controls given the overriding obligations imposed on Chinese companies by state security law.

For European and US policymakers, the data dimension represents a second layer of strategic risk from Chinese EV proliferation, beyond the immediate industrial competition, with implications that extend into critical infrastructure protection and democratic governance.

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Appendix A. Regulatory Frameworks and Industrial Policies

Policy approaches to automotive electrification are increasingly diverging across the major markets (see Table).

Table A1 - Policy frameworks for automotive electrification in major economies

Dimension	China	EU	U.S.	Japan	South Korea
Strategic objective	EV leadership and supply-chain dominance	Decarbonization and competitiveness	Domestic manufacturing and energy security	Technological neutrality and export competitiveness	Export competitiveness and electrification
Main instruments	NEV mandate, dual-credit system, integrated supply-chain policy support	CO_2 fleet standards	Incentives, tariffs and localization policies	Technology-neutral incentives (hybrids and BEVs)	Industrial coordination, EV incentives and R&D support
Consumer incentives	Strong	Moderate (significant intra-EU variation)	Reduced post-2025; politically uncertain	Limited	Moderate
Charging infrastructure	Rapid nationally coordinated rollout	Expanding but geographically uneven	Geographically uneven; limited federal coordination	Slow public expansion	Extensive urban expansion; uneven outside major cities
Current trajectory	BEV-led growth; dominant global market share	Gradual electrification; implementation pace under review	Slower transition; high policy uncertainty	Hybrid-dominated pathway	Balanced BEV expansion with strong export orientation

China combines industrial policy, scale and supply-chain integration and control over battery and critical-mineral supply in support of battery-electric vehicles. The European Union remains committed to decarbonization but is recalibrating implementation to balance climate objectives against industrial competitiveness concerns, particularly in light of competitive pressure from Chinese manufacturers.

The United States has shifted toward a more protectionist and hybrid-oriented trajectory, with greater policy uncertainty surrounding the pace of electrification. Japan continues to favor a technology-neutral approach, supporting hybrids alongside battery-electric vehicles, reflecting the competitive position of its incumbent manufacturers. South Korea combines active electrification policies with strong industrial coordination, sustaining both domestic demand and export competitiveness.

These differences are increasingly fragmenting the global automotive industry into distinct regional ecosystems. As incentives, emissions standards, sourcing requirements and trade policies diverge, OEMs are increasingly forced to maintain multiple technology pathways simultaneously, increasing complexity, reducing scale economies and complicating long-term investment planning (RSM Global, 2026).

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