XAIA INVESTMENT
Quarterly Letter
2024|04

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In southern Germany, we have long been proud of our automotive industry, which has historically been a cornerstone of our economy. It is disheartening to witness these companies now facing significant challenges. Recently, much of the news has focused on the struggles of German carmakers, but the trend underneath is more widespread with multiple factors at play. We have used the quiet period around the year's end to take a closer look at the issue.

The automotive industry is at a pivotal moment, with four major factors shaping its future. First, technological advancements are driving a fundamental shift from Internal Combustion Engine (ICE) vehicles to New Energy Vehicles (NEVs), including the rise of software-defined cars. Second, China's growing dominance in NEV production, fueled by strategic subsidies and investments, is reshaping global competition. Third, the evolving landscape of tariffs and CO_2 regulations adds significant uncertainty, impacting automakers' ability to plan and invest. Finally, the need for agility and scalability in production is becoming more crucial than ever as traditional players face new challenges from emerging competitors. These forces will determine the future trajectory of the industry, demanding adaptability and innovation across the board.

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China: The beneficiary of the NEV revolution

The rise of New Energy Vehicles (NEVs) is dramatically reshaping the global automotive industry. NEVs encompass both Plug-in Hybrid Electric Vehicles (PHEVs) and Battery Electric Vehicles (BEVs). The transition from Internal Combustion Engine (ICE) vehicles to Electric Vehicles (EVs) signifies a complete transformation of automotive design, replacing the traditional engine and fuel tank with electric motors and a battery pack. This shift also revolutionizes the electrical and electronic (E/E) architecture of vehicles, moving from a complex, distributed system to a more centralized approach.

Wolfgang Reitzle, former CEO of Linde and an executive at Ford and BMW, has observed that "the rise of New Energy Vehicles (NEVs) presents a unique opportunity for the Chinese, one that they are unlikely to let slip away."

Reitzle's insight has been confirmed in 2024, as China has far exceeded its NEV production target set in the "Made in China 2025" plan. Instead of the original target of 7 million NEVs for 2025, China is on track to produce 12 million units in 2024, with 7-8 million of those being full electric or BEVs. NEVs now represent over 50% of China's total automobile sales. In contrast, NEV sales in Europe have struggled to surpass the 22.7% market share achieved in 2023.

The Failed Real Estate Policy: An Accelerator for a More Export-Oriented Industrial Policy

To understand China's current economic situation, it is crucial to step back and analyze the role of capital allocation in the economy. While China's export power and supply-side policies are well-known, the scale of capital investment in the production sector is staggering. Capital formation (industrial capacity) as a share of GDP has remained around 45% for over a decade. In simpler terms, nearly 45 cents of every dollar in GDP growth has been allocated to developing real estate, infrastructure, factories, and purchasing manufacturing equipment.

For comparison, India, another high-growth emerging economy, currently allocates about 30%, while Japan, the former export powerhouse, peaked at around 35% in the 1970s and 80s. China's economic growth has largely been driven by strategic capital investments, guided by the Communist Party's five-year plans. This centralized approach has allowed the government to selectively support specific industries, effectively choosing "winners and losers".

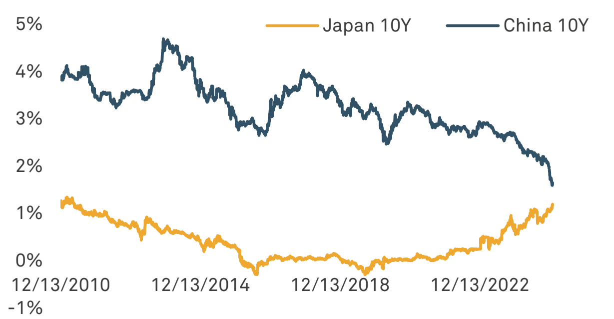
Accompanying this has been China's version of the Japanese "window-dressing", in which the central bank directs commercial banks to offer loans to targeted industrial sectors. This monetary policy tool has been instrumental in driving growth in certain sectors but has come at the cost of consumer spending. This export-oriented model means that when domestic demand cannot absorb the excess production capacity, Chinese industries are forced to export their surplus goods.

The CCP's Current Economic Predicament

Why is the Chinese Communist Party (CCP) now in such a desperate situation to generate growth? The engine of growth – real estate – has turned into one of the largest bubbles in history. Real estate accounts for around 25% of China's economy, 36% of local government revenue, 70% of household wealth, and 10% of employment. Moreover, it has been the space for accommodating the migration of over 570 million people from rural to urban employment since 1992. However, today the sector faces significant challenges. A staggering amount of real estate is either vacant or unfinished, and the valuation of properties is highly inflated, with vacancy rates approaching 20%.[1]

China's debt-to-GDP ratio (including government, local government, private and corporate debt) has reached 318%[2], not far from the developed economies average of 330%, and about 200 percentage points higher than other emerging economies. Even if the unfinished buildings are completed, the excess supply will take years to absorb, diminishing the need for future housing and infrastructure investment. Consequently, the negative growth from real estate investments will drag down GDP growth. In simple terms, if real estate (e.g. 20% of total GDP) growth falls from 5% to -1%, other sectors must grow at 7% to maintain the target GDP growth rate of 5%.

CHART 1: 5% TREND GDP GROWTH – REALLY?
Japan 10Y Govt Yield vs. China 10Y Govt Yield



Source: Bloomberg, XAIA Investment GmbH

The Road Ahead: Solutions to China's Economic Crisis

In addressing a balance sheet recession, Richard Koo's work[3] provides a useful framework. His solution for Western economies involves deleveraging the private and corporate sectors through government deficit spending, with central banks monetizing the debt to avoid a fiscal cliff – a situation where consumer spending contracts due to fears of job loss and falling asset prices. So far, China has not implemented a meaningful fiscal stimulus; instead, it has adopted a hybrid policy mix, focusing on higher-quality investments in sectors like technology and materials science, alongside an emphasis on boosting exports. One mental model that we find useful is the idea of a "runaway assembly line" economy. As the losses from real estate investments mount, China has had to double down on its assembly line business model. However, China is already a major exporter, and this strategy has its limits. After being hit hard by the Asian financial crisis, South Korea was able to devalue its currency, transitioning from a net importer to a net exporter and overcoming its economic challenges. A similar depreciation of the Chinese yuan could enhance the competitiveness of Chinese products abroad, but this would likely provoke increased retaliation from key consumption markets, such as the US and Europe. China's bond market has already begun to reflect concerns over the economy's structural weaknesses, with bond yields closing in on those of Japan. These combined factors suggest that while China's export-oriented approach could offer short-term relief, it may also face increasing friction with its major trading partners, complicating its long-term recovery prospects.

The Largest Subsidies Parachute in Human History

Amid China's challenging economic environment, it becomes clearer why the Chinese Communist Party (CCP) has supported various industries in an effort to replace real estate as the primary growth driver. For nearly two decades, China's industrial policy has driven considerable success. In 2023, China accounted for over 80% of global solar cell exports, more than 50% of lithium-ion batteries, and over 20% of electric vehicles (EVs). While multiple factors contribute to this success, the most significant factor by far is the extensive subsidization of selected industries.

1 https://thedailyeconomy.org/article/the-case-of-evergrande-is-there-a-housing-bubble-in-china/
2 https://www.fidelityinternational.com/editorial/article/how-china-keeps-its-debt-in-order-e1feea-en5/
3 https://blockworks.co/podcast/forwardguidance/7f6e4ad0-7216-11ef-ac65-3b4c557d5436

FIGURE 1: VW EVERY YEAR IN SUBSIDIES

Industrial Policy Spending for China's NEV Sector in billion USD

Type of	2009–17	2018	2019	2020	2021	2022	2023	Total
Rebate	37.8	4.3	3.3	3.5	7.4	9.2	0.0	**65.7**
Sales Tax Exemption	10.8	7.7	6.4	6.6	16.4	30.3	39.6	**117.7**
Infrastructure Subsidies	2.3	0.2	0.2	0.3	0.3	0.6	0.6	**4.5**
Research & Development	2.0	3.6	3.4	3.5	4.3	3.9	4.3	**25.0**
Government Procurement	7.8	1.6	1.4	2.9	1.7	1.8	0.8	**18.0**
Total	**60.7**	**17.4**	**14.8**	**16.8**	**30.1**	**45.8**	**45.3**	**230.9**
Spending as Share of Total Sales	42.4%	22.7%	23.3%	25.4%	18.3%	15.1%	11.4%	**18.8%**
Subsidy per Vehicle (USD)	-	13,860	12,310	12,290	8,540	6,660	4,760	**-**

Source: https://www.csis.org/blogs/trustee-china-hand/chinese-ev-dilemma-subsidized-yet-striking

According to extensive research by the Center for Strategic and International Studies (CSIS), subsidies for New Energy Vehicles (NEVs) in China totaled approximately USD 230 billion from 2009 to 2023. This staggering amount – far exceeding the current market value of Volkswagen, which stands at around USD 45 billion – represents just a portion of the total support, as it excludes several critical forms of backing. These include local government rebate programs encouraging the switch from internal combustion engine (ICE) vehicles to NEVs, as well as the provision of low-cost land, electricity, and credit. In 2022, the auto sector received loans at roughly 2% interest, half the weighted average rate for commercial and industrial loans. Additionally, local governments have made equity and credit injections into companies like NIO, alongside subsidies to key suppliers, such as battery manufacturers.

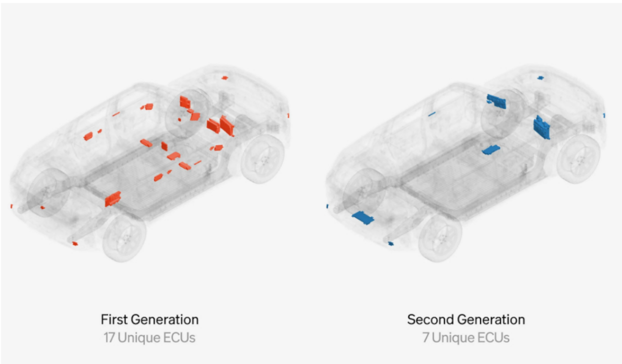
The shift in local government focus from real estate to NEV industry support is particularly noteworthy. Historically, local governments relied heavily on revenues from land sales and real estate-related taxes. However, as the real estate sector slows, these governments are increasingly turning to the NEV industry as a new source of growth. This transition has resulted in extensive subsidies and support for NEV producers, dramatically lowering start-up costs. The combination of government backing and local supply chain support has made establishing NEV production facilities in China remarkably easy, enabling the rapid and cost-effective establishment of new operations.

ICE vs. NEV: The Overlooked Architectural Revolution

The transition from Internal Combustion Engine (ICE) vehicles to New Energy Vehicles (NEVs) is not only reshaping the automotive industry but also driving a profound revolution in vehicle architecture. At the heart of this transformation lies the evolution of Electrical/Electronic (E/E) systems, where traditional ICE vehicles rely on over 100 Electronic Control Units (ECUs) connected by complex wiring systems, while NEVs are adopting a centralized processing model with fewer, more capable controllers through a shift from domain to zonal architecture. Rivian's remarkable progress illustrates this transformation, reducing ECUs (Electronic Control Units) from 100 to 17 to just 7, cutting 1.6 miles of wiring, and decreasing vehicle weight by 44 pounds, while Tesla has leveraged this simplified architecture to halve production times compared to traditional OEMs (Original Equipment Manufacturers). This architectural evolution represents more than a technical upgrade; it signifies a fundamental reimagining of vehicle design, enabling reduced complexity, lower costs, faster production, and setting the stage for more software-defined, adaptable automotive platforms that can rapidly incorporate technological innovations.

FIGURE 2: ECUS DROPPING

Visualization of ECUs per Rivian generation



Source: Rivian

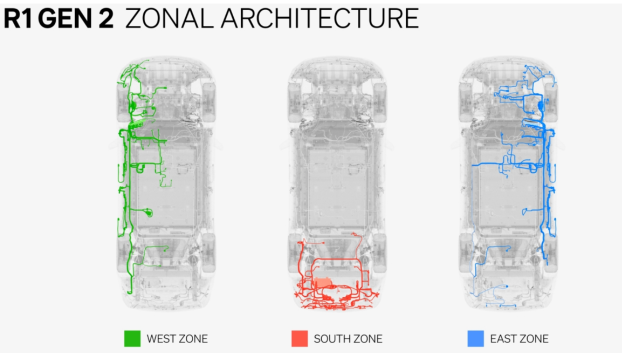
As NEVs evolve into Software-Defined Vehicles (SDVs), the automotive development process is undergoing a fundamental change. In the ICE world, manufacturers prioritized hardware design, treating software as an afterthought. In contrast, NEVs take a software-first approach, with hardware designed to support software functionality. This shift allows Original Equipment Manufacturers (OEMs) to control the interface between consumers and their digital lives, opening new opportunities for monetization through digital services and features.

This transformation mirrors the smartphone revolution, where separate devices for communication, music, and gaming merged into a single multifunctional device. Similarly, in modern vehicles, systems like radio, air conditioning, and safety features are being integrated into a unified, software-driven platform. As vehicles surpass thresholds for automated and connected driving, OEMs are developing proprietary Software Development Kits (SDKs). These SDKs provide a standardized foundation upon which developers can build applications, insulating software functionality from underlying hardware.

For example, a climate control app in the infotainment system would communicate with the central vehicle controller via APIs, which would then send signals to various actuators such as compressors, fans, and flaps. This separation of software from mechanics enables continuous optimization of the user experience. Without a robust SDK and a capable Central Vehicle Controller (CVC), the software-defined vehicle cannot function.

FIGURE 3: ZONAL ARCHITECTURE IS REPLACING DOMAIN ARCHITECTURE

Visualization of Rivian's zonal architecture



Source: Rivian

Traditional cars had fixed features that didn't evolve over time, so OEMs focused on minimizing material costs. In contrast, modern vehicles need additional hardware capacity to accommodate future software updates, such as Tesla's "Dog Mode"[4]. In the past, OEMs outsourced components, including hardware and software, often without access to the source code. Today, OEMs must control the code to continuously improve functionality. The most critical aspect of differentiation – customer experience – will increasingly depend on software developed in-house, not outsourced to suppliers.

Another key feature of NEVs is their ability to receive over-the-air updates, similar to smartphones. This capability allows for continuous improvement in vehicle performance and helps maintain higher residual values while adding new features post-purchase.

China's digital-first society is a significant driver of innovation in this space. With apps like WeChat seamlessly integrated into daily life, the need for vehicles to integrate into digital ecosystems is becoming essential. For instance, during long red light phases that can last up to eight minutes, Chinese drivers often use the time to shop or enjoy karaoke in their vehicles. Additionally, there is a notable demographic difference: The average Mercedes S-Class buyer in Germany is typically in his late 50s, while in China, he is usually between 36 and 38 years old, making him more digitally savvy.

Xiaomi has recently launched its "Porsche Taycan Killer", a vehicle that stands out for its continuous digital ecosystem, which spans from smartphones to household appliances and, now, the car itself. Unlike traditional automakers, where users switch from their personal ecosystem to a separate infotainment system, Xiaomi offers a seamless experience. The vehicle becomes an extension of the user's digital life, offering the same interface and functionalities as their smartphone. While the SDV is still a future prospect in the West, it is already a reality in China. We believe that, while the Chinese economic system has its flaws, it has delivered extraordinary results in certain sectors, particularly in automotive innovation.

This software-first approach represents a paradigm shift in automotive design and user experience. As NEVs evolve into SDVs, the distinction between mobile devices and vehicles is blurring, creating a new frontier for digital integration and user-centric design in the automotive industry.

The automotive industry's platform architecture is also evolving. In the ICE world, Volkswagen's Modularer Querbaukasten (MQB) platform was crucial in reducing costs during the 2010s by enabling flexible design across multiple brands and models. Today, the focus is shifting to platforms like Volkswagen's Scalable System Platform (SSP), which simplifies the use of shared components across models, resulting in reduced R&D costs and better integration of hardware and software.

In the realm of automotive operating systems, various approaches are emerging. Some manufacturers, like Volkswagen with its Cariad initiative, have faced significant challenges, leading them to pursue joint ventures with companies like US-based Rivian and Chinese automaker Xpeng. This trend highlights the growing divide between China and the Western world, a division that could be further deepened by US legislation aimed at restricting the use of Chinese-developed software and hardware in connected vehicles.

The rationale for developing proprietary software and restricting access to platforms like Android and iOS is clear: Automakers want to capture more value from the digital ecosystem during the time consumers spend in

4 https://www.notateslaapp.com/tesla-reference/603/tesla-dog-mode-everything-you-want-to-know

their cars. However, it remains uncertain whether consumers would prefer using a vehicle's native interface over more familiar ecosystems like iOS or Android, particularly when driving a BMW. In contrast, Xiaomi has successfully created an SDV with its own operating system, while Tesla leads in the West in SDV integration, with BMW not far behind among traditional OEMs.

Chinese NEV Manufacturers' Competitive Edge: Rapid Development and Vertical Integration

The shift towards NEVs has significantly shortened time-to-market for manufacturers. Chinese NEV start-ups, operating in shifts, can expedite development, as electric vehicles are inherently simpler to design with fewer mechanical components. This agility allows these companies to align more closely with consumer preferences, while traditional automakers, facing longer development cycles, must extend production times to recoup R&D costs. European OEMs also aim to shorten development timelines, but they often bypass steps like extensive winter testing, which Chinese manufacturers can skip.

Vertical integration is another crucial aspect of this transformation. For instance, BYD has taken control of various production stages, from sourcing rare earth materials to manufacturing battery cells, packs, and final batteries. This insourcing strategy allows BYD to capture a larger portion of the value chain. Historically, OEMs outsourced many components, retaining only essential parts like motors and chassis in-house. However, with capital costs nearly negligible for some Chinese firms, they can grow rapidly without the same financial constraints faced by their Western counterparts. Additionally, Chinese OEMs benefit from a localized supplier network that provides competitively priced components.

Batteries – the core of the BEV

At the core of New Energy Vehicles (NEVs) are batteries, accounting for up to 40% of total vehicle cost. CATL and BYD dominate the market, holding approximately 53% of the global EV battery share. China's planned battery production capacity by 2026 is expected to be nearly seven times greater than demand, indicating potential overcapacity. Battery plants are capital-intensive investments, often exceeding USD 1 billion.

China's subsidized electricity makes NEVs cost-competitive, with prices around 6 cents per kWh compared to 21 cents in Europe. Lithium-ion battery pack prices have reached record lows at USD 139/kWh, with cell-level prices for BEVs at USD 89/kWh. Scale remains crucial for profitability in both ICE and NEV sectors.

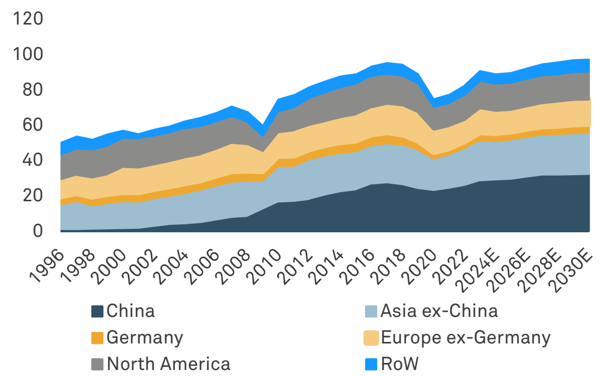
China dominates the battery mineral supply chain, processing 67% of global lithium, 73% of cobalt, 70% of graphite, and 95% of manganese. It also produces 90% of battery cathodes, virtually all anodes, and over 80% of final battery cells. Non-Chinese OEMs lag in battery technology and mineral production access.

However, the extent of China's advantage and cost benefits remains unclear, especially in an oversupplied market. The pace of advancements in solid-state batteries and their potential impact are also uncertain. Great Power claims to be developing a solid-state battery with 280 Wh/kg energy density, aiming for mass production by 2026, but its viability and competitiveness are yet to be proven.

The Supply and Demand Picture

Historically, the automotive industry has been dominated by regional champions in their respective home markets. General Motors and Ford led the US market, Volkswagen held sway in Europe, and Toyota was the dominant force in Japan. However, China represented a unique case, where Volkswagen led sales until recently. The recent overtaking of Volkswagen by BYD signals a return to the trend of local dominance in the Chinese market.

CHART 2: CHINA IS EATING THE WORLD
Global vehicle production (million cars) per jurisdiction



Source: Bloomberg, XAIA Investment GmbH

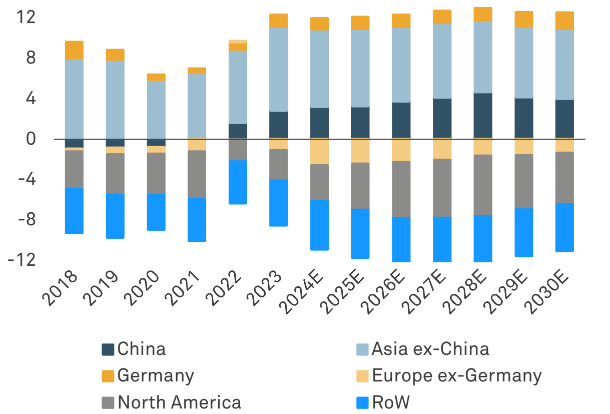
Global vehicle production peaked at 95 million units in 2017/2018 but has yet to fully recover. In comparison, the 2009 low was 60 million units. China's production has surged from 9 million to 28 million units, while production in the EU has remained flat at around 16.5 million units. North America (US, Canada, Mexico) has seen production grow from 12 million to 16 million units, partially driven by reshoring efforts. Together, these three regions form the largest vehicle production hubs globally.

Europe experienced a six-year market contraction from 2008 to 2013, followed by a period of growth from 2014 to 2017, before contracting once more in 2018.

The import export picture is more nuanced. Europe is quasi-balanced. However, Germany, exports more expensive models and imports cheaper cars. North-America is a net-importer, Asia a net-exporter and China emerges as well as a net-exporter.

CHART 3: CHINA CATCHING UP

Difference in vehicle production and sales per jurisdiction (million cars)



Source: Bloombeg, XAIA Investment GmbH

The automotive market is typically divided into three main segments: entry-level, mid-range, and premium. Luxury brands such as Ferrari are often classified separately. The premium segment, dominated by German manufacturers like Audi, BMW, and Mercedes-Benz, generates the highest profit margins, which are only topped by the luxury segment.

Post-pandemic, automakers faced considerable supply chain challenges, which forced them to prioritize production of their most profitable models, thereby improving margins. However, as supply chains normalize, this temporary advantage is diminishing.

During the 2010s, suppliers enjoyed higher profitability than OEMs, benefiting from consistent growth and gradual capacity expansion. However, since the 2017 peak – especially in Europe – car production has underperformed expectations, leaving suppliers with excess capacity. While suppliers benefited from production growth and reduced pricing pressure from OEMs in the 2010s, the early 2020s saw OEMs optimize their product mix, improving margins. Meanwhile, suppliers struggled with lower production volumes and reduced fixed cost absorption.

China's automotive market has undergone a significant transformation, shifting from a growth driver for non-Chinese manufacturers in the 2010s to a landscape dominated by domestic players with high EV market share, buoyed by government subsidies. Despite the surge in EV volumes, profitability remains elusive, with all battery electric vehicles (BEVs) currently operating at negative margins. Even BYD, with its vertically integrated structure offering cost advantages across the value chain, relies on its plug-in hybrid electric vehicles (PHEVs) to turn a profit. While economies of scale are expected to improve profitability, the true profit potential of EVs without additional revenue streams like CO_2 certificates remains uncertain.

The disparity in charging infrastructure development presents a stark contrast between China and its Western counterparts. As of July 2024, China boasts over 3.2 million public charging points, dwarfing the United States' 181,118 and Europe's 900,000. This vast network in China facilitates rapid EV adoption, while the lagging infrastructure in the US and Europe poses a significant barrier to widespread EV uptake. For New Energy Vehicles (NEVs) to achieve higher adoption rates, they must not only reach cost parity with internal combustion engine (ICE) vehicles but also offer a superior consumer experience. Reimagining the car as more than just a mode of transportation, akin to the evolution seen in consumer electronics, could potentially elevate BEVs above their ICE counterparts, driving increased adoption despite infrastructure challenges in some regions.

The Wild Cards – Tariffs and Regulations

The automotive industry is capital-intensive, requiring long lead times for investments. Legislators need to create stable, long-term frameworks that provide OEMs with the foresight to plan effectively. Sudden changes in tariffs or CO_2 regulations can disrupt this framework, making it harder for automakers to make strategic decisions. In such a volatile environment, flexibility becomes crucial for OEMs.

In the EU, CO_2 regulations impose costs on OEMs for every vehicle sold that fails to meet emission targets. While OEMs like BMW and Volvo are close to meeting their targets, others, such as Volkswagen, lag behind. A delay in these targets would act as a multi-billion-dollar subsidy for certain OEMs, providing them with a temporary advantage.

Tariffs significantly impact the automotive industry by increasing costs for imported goods, affecting carmakers differently based on their production strategies. The industry's reliance on scale and centralized production for profitability is threatened by the potential need to produce vehicles in each sales market. The unpredictable nature of tariff implementation creates uncertainty for producers and supply chains, with companies having a mismatch between production and sales geography likely to suffer the most.

Tariffs are an additional cost, increasing the sticker price of the good. The additional cost is considered to be paid by the consumer and earned by the respective importing government agency (i.e. US treasury), therefore leading to higher costs for the consumer. However, nothing happens in a vacuum and countries, like China, can lower its production costs (lower wages, lower FX, subsidies) to offset tariffs. In this case, tariffs can be beneficial for the US. For more on this topic, please see Michael Pettis work.[5]

The United States' automotive industry faces significant challenges due to recent and potential tariff policies. China, Mexico, and Canada account for approximately 40% of US imports, making them the most affected by US tariffs, with Germany following at about 5%. In May 2024, President Biden imposed a 100% tariff on Chinese EVs, effectively closing the US market to Chinese electric vehicle imports. However, a more pressing concern for existing supply chains is the potential 25% tariff on imports from Canada and Mexico, key partners under the USMCA. This is particularly impactful as roughly one in four vehicles sold in the US is imported directly from these countries. Moreover, such tariffs would severely disrupt the highly integrated North American automotive supply chain, which depends on the free flow of parts and components among the three nations. The proposed tariffs could "break the entire system" of the North American automotive supply chain, potentially reshaping production strategies and increasing costs for manufacturers and consumers alike.

Several major automakers would be significantly impacted by tariffs on vehicle imports to the US. General Motors (GM) and Stellantis are particularly vulnerable due to their heavy reliance on production in Mexico and Canada, with GM importing models like the Chevrolet Silverado and Stellantis producing RAM and Jeep vehicles. European automakers like Volvo Cars, Jaguar Land Rover (JLR), and Volkswagen Group would also face challenges, as they import a significant portion of their vehicles from Europe, including premium models from Audi, Porsche, and JLR. Toyota, Hyundai-Kia, and Honda are additionally exposed due to their production facilities in Mexico and Canada, with Toyota producing the Tacoma in Mexico and the RAV4 in Canada, while Honda exports 80% of its Mexican production to the US. These companies would face considerable cost increases and potential disruptions to their supply chains if tariffs were imposed.

A 25% tariff on automotive imports from Mexico could have a substantial impact on automakers' profits and margins. S&P Global estimates that affected European and US automakers could lose up to 17% of their combined annual EBITDA in a worst-case scenario. Companies like General Motors and Stellantis are particularly vulnerable, with potential EBITDA risks exceeding 20%, while others like Volkswagen and Toyota could see 10-20% of their profits affected. The impact is amplified by the complex cross-border supply chains, with many components crossing borders multiple times. While some automakers could potentially shift production to the US, this would require significant time and investment, leaving them exposed in the short to medium term.

Europe has imposed tariffs ranging from 7.8% to 35.3% on Chinese-made electric vehicles, in addition to the standard 10% car import duty, in response to the perceived threat of subsidized EV imports from China. While producing in Europe avoids these tariffs, current production capacity for Chinese brands remains limited. By 2030, BYD and SAIC are projected to produce 130,000 units, Geely 50,000 units, and Chery 40,000 units in Europe. Despite these tariffs, Chinese EVs maintain profitability in the European market. BYD, for instance, earns approximately EUR 13,000 more on each BYD Seal exported to Europe compared to domestic sales. In contrast, European automakers face tighter margins on their China-produced models. The BMW iX3 SUV, for example, has a profit margin of around 9% when produced in China, which could be eliminated by duties exceeding this percentage.

Suppliers – Content per vehicle is key

The automotive supply chain is evolving, with OEMs, Tier 1, and Tier 2 suppliers adapting to new industry dynamics. OEMs focus on vehicle design and assembly, while Tier 1 suppliers integrate complex systems, and Tier 2 suppliers produce specialized components. This relationship is becoming more collaborative, with suppliers increasingly involved in early product development stages.

Content per vehicle, a key metric for supplier revenue, is calculated by dividing global revenue by global vehicle production. For example, Forvia's content per vehicle increased from EUR 298 in 2022 to EUR 301 in 2023. Suppliers are more volume-driven than OEMs, with their performance closely tied to production growth and content/mix variations. Despite intense OEM competition in China, margins remain high, mainly due to scale and cost advantages.

BEVs typically have higher content per vehicle due to expensive batteries and advanced electronics, despite simpler powertrains. However, OEMs like Renault and GM aim to reduce costs per car and thus content per car significantly, potentially impacting supplier revenues. This makes sense, as the run-up in car prices and financing costs hinders further LVS (Lower Light Vehicle Sales) growth.

The industry is transitioning from hardware-defined to software-defined vehicles (SDVs). This shift is changing the relationship between hardware and software, potentially leading to greater commoditization of parts and better software monetization. The profit pool for

5 https://carnegieendowment.org/research/2024/10/trade-intervention-for-freer-trade?lang=en

semiconductors and batteries has grown from 4% to nearly 20% over the past 20 years.

While OEMs continue to outsource R&D, the SDV paradigm is reducing the number of Electronic Control Units (ECUs), challenging traditional profit sources for Tier 1 suppliers. The simplicity of BEVs is shifting value-add from mechanics to digital features, altering supplier dynamics and profit pools. In the Internal Combustion Engine (ICE) era, value was primarily derived from mechanical engineering, emphasizing driving experience ("Freude am Fahren"). However, in the New Energy Vehicle (NEV) and SDV landscape, value creation is increasingly centered on infotainment systems and a more integrated, seamless transportation experience. This shift presents both challenges and opportunities for suppliers; while traditional hardware-based revenue streams may diminish, the growing importance of software in SDVs offers potential for higher-margin business models. Suppliers who can successfully pivot to develop and monetize software solutions for these next-generation vehicles may find new avenues for profitability in this evolving automotive ecosystem.

Shorter development and production cycles, especially for Chinese OEMs, make it harder for suppliers to recoup R&D investments. Lower Light Vehicle Sales (LVS) figures further complicate capex recovery, while OEMs pressure suppliers to invest in EV and SDV transitions.

Profit pools are shifting, with margins eroding in classic segments (ICE/PHEVs, post-sale service, finance) and growing in emerging areas (BEVs, digital services, on-demand mobility). China's expected volume growth may boost its classic profit pools.

A critical factor in the automotive supply chain is the opacity surrounding supplier segment profitability. The inverse relationship between part commoditization and supplier margins is evident, with suppliers commanding higher margins for specialized components that require substantial R&D investment – an area OEMs may lack expertise or willingness to pursue. This dynamic creates a delicate balance where suppliers of highly specialized or strategically crucial parts can negotiate more favorable margins. However, this model presents significant risks, particularly in the context of industry-wide shifts. Suppliers heavily invested in internal combustion engine (ICE) technologies or components becoming obsolete face disproportionate profitability declines as the industry pivots towards electrification and new technologies. For instance, a supplier like American Axle, whose profitability hinges on expertise in heavy-duty truck powertrains, could face severe margin compression if a major client like General Motors reallocates contracts to competitors more aligned with future automotive trends.

Compared to OEMs, suppliers haven't cleaned up their capital structure. The already elevated leverage would require an increase in vehicle production and thus an increase in organic FCF to de-lever and thus de-risk the credit profiles. Those lagging in R&D, heavily reliant on ICE production, or unable to monetize software may struggle. The industry requires significant investment in software-related projects.

Generally low-margin businesses, suppliers find it difficult to raise capital through equity due to low market capitalizations. While they trade wide for their ratings, they remain expensive relative to equity. Historically positive free cash flow has allowed for deleveraging, and diversified operations provide opportunities for disposals.

Net leverage ratios (e.g., 3.1x for ZF, 2.0x for Forvia) appear low but could increase rapidly with further profitability declines. The capital-intensive nature of the industry, combined with potential working capital swings and ongoing disruption, creates a challenging environment for suppliers. Remember, (structural) change is rarely positive for credit investors.

Relative Value in the sector

Chinese automakers have defied profit expectations due to extensive government support, including subsidies and tax rebates. While international car manufacturers, except Tesla, manage dual powertrains and face tough capital allocation decisions, ICE models remain more profitable than BEVs. Volvo's BEV gross margins have improved to 13% in 2H23, still below the low 20s margin for ICE models. Their new entry-level EV, EX30, is expected to achieve 15-20% gross margins, illustrating the persistent gap between ICE and BEVs.

While prolonging ICE production seems beneficial overall, this strategy varies by manufacturer. China's shift towards EVs and autonomous driving threatens the high margins German premium brands once enjoyed there. The potential rollout of autonomous solutions like the cybercab in 2027 could disrupt car ownership patterns and sales volumes.

European automakers and suppliers are trading at historically low valuations, with 2026E P/E ratios for Daimler, BMW, and VW at 5.7x, 6.6x, and 3.3x respectively. Paradoxically, credit spreads for VW, though elevated, remain relatively tight and don't reflect the equity underperformance. European suppliers like Forvia, Schaeffler, and Valeo have lost about 70% of their market cap over a decade, trading as depressed as OEMs. Their 5y CDS spreads indicate increasing credit risk, with Forvia and ZF in the high 300bp range, yet the gap between equities and credit remains wide.

This disconnect may be due to positive technicals in credit markets. Further fundamental deterioration could narrow this gap, reminiscent of trends in other challenged industries like Satellites. In the US, the Big Three trade around 4x P/E, while Tesla commands 100x. The supplier space shows value discrepancies, particularly with American Axle and Dana. While credit investors are often considered more prescient, in this case, equity investors seem to have anticipated the industry's trajectory ahead of their credit counterparts.

At crossroads

The book "Engines That Move Markets: Technology Investing from Railroads to the Internet and Beyond" provides a fascinating insight into the early automotive industry, drawing parallels with recent developments in China's New Energy Vehicle (NEV) sector. The automotive industry's nascent stage in the early 1900s United States mirrors the current NEV boom in China, illustrating the cyclical nature of technological revolutions. In the US, approximately 200 companies ventured into car production, a figure strikingly similar to the recent surge of NEV startups in China. Both eras are characterized by high corporate failure rates, underscoring the inherent risks in emerging industries. Even industry giant General Motors faced financial turmoil, defaulting twice in its formative years. The automotive sector experienced peak volatility during two critical periods: 1909, when market entrants reached an all-time high (analogous to China's current NEV landscape), and 1924, when shifting economics reshaped the industry. The latter period saw increased vehicle affordability and a growing emphasis on economies of scale, factors that proved decisive in determining which companies would survive and thrive.

This historical parallel offers valuable lessons for today's NEV market, suggesting that a similar consolidation may occur as the industry matures and economic realities evolve.

The automotive industry is undergoing a profound transformation driven by a mix of technological, regulatory, and geopolitical factors. From China's remarkable shift towards a new growth model, powered by subsidies and a push for New Energy Vehicles (NEVs), to the ongoing revolution in vehicle architecture and software, these dynamics are reshaping global production and market leadership. While traditional giants face growing competition from agile local players like BYD, the shift to software-defined vehicles and vertically integrated supply chains will further alter the competitive landscape. Additionally, tariffs and regulatory changes remain wild cards, potentially upending the strategies of both established and emerging automakers.

In conclusion, the automotive sector is at a critical inflection point, with technological advancements and government interventions playing pivotal roles in determining future success. China’s strategic subsidies, particularly in the NEV sector, have positioned it as a formidable force, challenging traditional Western manufacturers. The shift to software-first, scalable architectures in vehicles is not just a technological trend but a fundamental shift in how OEMs approach design, development, and consumer engagement. At the same time, the growing complexity of tariffs and emissions regulations adds an additional layer of uncertainty, requiring flexibility and foresight from all players. Ultimately, scale, technological agility, and the ability to navigate regulatory landscapes will be the key determinants of success in the coming years.

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