6. Efficiency of market structure: The electric vehicle (EV) industry

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Marta Warsewicz
https://orcid.org/0009-0001-3689-5905
Poznań University of Economics and Business
Marta.Warsewicz@ue.poznan.pl

Maciej Szymczak
https://orcid.org/0000-0002-1107-3390
Poznań University of Economics and Business
Maciej.Szymczak@ue.poznan.pl

ABSTRACT

Purpose: This study explores the market structure of the electric vehicle (EV) industry and its impact on various types of market efficiency: allocative, productive, and dynamic.

Design/methodology/approach: The EV market, which has experienced rapid growth in recent years, operates in a mixed-market structure that combines both oligopolistic and fully competitive segments. This study examines the role of major players and emerging startups in niche markets through a comprehensive analysis of the literature, industry reports, and market data.

Findings: This study finds that allocative efficiency is difficult to achieve in the EV sector because of the price-setting power of dominant firms. This is realised through economies of scale and technological innovation, while dynamic efficiency is driven by competition among major players. The analysis also shows that while large companies benefit from economies of scale and drive innovation, smaller players struggle to achieve market share because of high barriers to entry, including capital investment and technological expertise. Despite the growth of the EV market, internal combustion engine (ICE) vehicles continue to dominate the automotive industry because of factors such as lower purchase prices and well-established infrastructure supporting them.

Originality and value: This study concludes by highlighting the crucial role of government policies and technological innovations in the ongoing transformation of the EV industry.

Keywords: market efficiency, market structure, electric vehicles, EV.

Introduction

The electric vehicle (EV) industry has attracted significant attention in recent years owing to its crucial role in addressing environmental concerns and transitioning to sustainable transport (Sun et al., 2018). As governments worldwide introduce stricter emission regulations and consumers switch to more environ-

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mentally friendly alternatives, the development of EVs has accelerated, as has demand for them (Zhang et al., 2018). The sector is characterised by a complex market structure that combines both competitive and oligopolistic characteristics shaped by technological innovation, government incentives, and the evolution of the automotive supply chain. The main objective of this analysis is to identify the EV industry's market structure and assess how this structure affects different types of market efficiency. This study focuses on three key types of efficiency: allocative, productive, and dynamic. To develop a comprehensive understanding of the EV market, this analysis covers a wide range of published sources, industry reports, and insights from EV manufacturers, policymakers and market analysts. These sources offer valuable information about the market trends, technological advances and regulatory frameworks that shape the industry. This study explores the EV industry, starting with an overview of its evolution and current trends, followed by an analysis of its market structure and its key players. It then examines the different types of market efficiency, concluding with a summary of the key findings and implications for the industry's future.

6.1. Electric vehicle market evolution and trends

The creation of EVs can be traced back to the 19th century. Early electric carriages were developed in the 1830s, with significant contributions from inventors such as Robert Anderson and Thomas Davenport. It was not until the early 20th century that EVs saw widespread use, especially in urban areas (Serra, 2013); however, the development of the internal combustion engine vehicles, with their higher speed, longer ranges, and wide availability of affordable fuel eventually overshadowed EVs. Although EV technology has been under development for decades, in recent years EVs have become more commercially accessible, consequently enjoying greater popularity among the public. In the 2010s, mass-market EVs, such as Nissan Leaf, BMW i3, Renault Zoe, and Chevrolet Bolt, brought EVs into the mainstream (U.S. Department of Energy, 2014), offering an accessible and commercially viable alternative for everyday consumers (Zhou et al., 2015). The global EV market has begun gaining significant commercial traction, marking a breakthrough in the transition to sustainable mobility.

Figure 6.1 demonstrates the growth in global sales of EVs, specifically passenger cars, from 2014 to 2024. It shows a significant increase in sales starting around 2017, with particularly strong growth registered from 2021 to 2024. While sales remained relatively low during the initial years, recent years have seen a noticeable upward trend, indicating a shift towards EVs in the automotive market. This increase in sales highlights growing consumer demand and the

transition towards electric mobility as a dominant force in the automotive industry. Key factors driving this shift include improvements in charging infrastructure, the introduction of more affordable models, and government incentives (such as subsidies or tax credits) supporting EV adoption (Huichen & Chen, 2023). The rise of popular models like the Tesla Model S and more affordable options like Nissan Leaf, BMW i3, Renault Zoe, Chevrolet Bolt and Tesla Model Y, which has been the world's best-selling EV since 2022, helped accelerate EV adoption, making electric cars more appealing to everyday consumers.

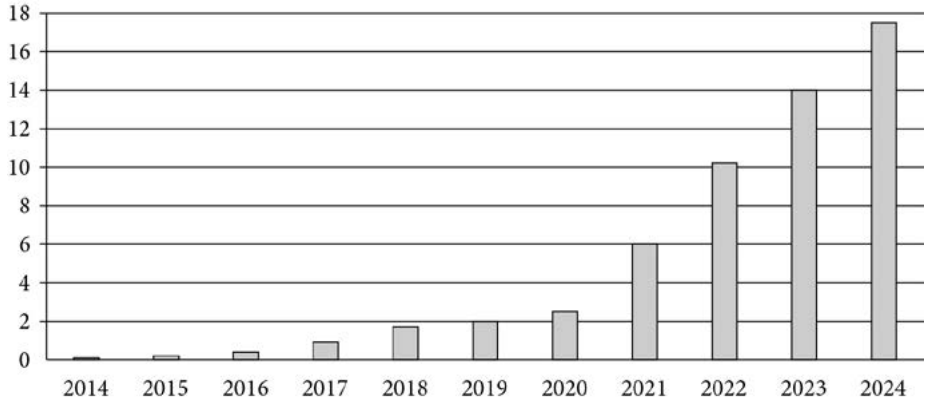

Figure 6.1. EVs sales market, passenger cars in millions

Source: adapted from Wicke (2025).

The global EV market is highly divided; in 2024, China emerged as a dominant player, accounting for approximately 45% of global EV sales, followed by Europe at 25%, the United States at 11%, and the remaining 19% of the other countries (IEA, 2024). China plays a pivotal role in the market, not only because of its large domestic market but also because of its competitive manufacturing capabilities and government support for EV adoption. Consequently, companies such as BYD, SAIC, Dongfeng and Geely, alongside other Chinese manufacturers, significantly influence prices, technological advancements, and production volumes. While global players such as Tesla continue to shape the market, China and its local companies have a substantial influence in terms of pricing and innovation. Consequently, smaller entrants, particularly those in niche segments or emerging markets, struggle to capture market share in an industry dominated by these key firms.

Although the EV market is experiencing rapid growth, internal combustion engine vehicles continue to dominate the automotive industry. Initially, manufacturers had high expectations for the rise in demand for EVs, believing that

electric cars would quickly overtake petrol-powered vehicles. However, the reality is that the market has become more complex. Despite optimistic growth projections for EVs, many consumers still prefer traditional cars with conventional combustion engines because of their lower price, wider availability, and greater convenience in everyday use. Concerns remain regarding EVs: the higher initial cost, the limited range and availability of charging stations continue to be barriers for many potential buyers. Additionally, many consumers stay loyal to well-established automotive brands, associating them with reliability and a long history of dependable vehicle production. Although the shift towards EVs is accelerating, it is still a gradual process, and ICE vehicles are expected to continue to be a dominant choice for consumers in the foreseeable future. However, as infrastructure improves and technology advances, the popularity of EVs will likely increase, gradually transforming the automotive market.

There has recently been a significant slowdown in EV sales in Europe. According to the European Automobile Manufacturers' Association (ACEA), the EV market in Europe is facing a continual downward trajectory, with EV sales dropping 43.9% year-on-year in August 2024 (Pappas, 2024). If this trend continues, it may lead to a change in the EU policy; from 2035, the production and sale of vehicles with ICEs will be banned.

6.2. Market structure

The EV industry is a rapidly evolving sector with a complex market structure that blends competitive and oligopolistic elements. On the one hand, the industry is dominated by several large global manufacturers, such as BYD, Tesla, Volkswagen, BMW, Wuling, and Li Auto, who hold a significant share of the market, especially in terms of mass-market vehicles (Çolak & Irmak, 2023). This creates an oligopolistic structure, in which a few key players control much of the market. However, there are numerous smaller players and startups entering the EV space, such as Canoo, Fisker, and WeaveGrid (Howarth, 2024), particularly in niche markets such as electric delivery vans, trucks, buses, motorcycles, scooters, mopeds, and specialty vehicles. These smaller companies contribute to the competitive dynamics of the industry and are crucial in driving innovation and pushing technological boundaries, such as advancements in battery technology, autonomous driving, and electric drivetrains. Additionally, the sector is heavily influenced by the growing number of companies involved in the EV supply chain, including battery manufacturers, software developers, and charging infrastructure companies.

In terms of service characteristics, the EV industry is distinguished by its focus on sustainability, energy efficiency, and maintenance costs. Unlike traditional vehicles, EVs produce zero emissions and offer consumers the benefit of significantly lower operating costs, such as fuel and maintenance costs, owing to fewer moving parts. The development of an extensive charging infrastructure is central to the EV market, with companies such as Tesla offering proprietary charging networks (e.g., Tesla Supercharger), whereas others, such as ChargePoint and Ionity, are expanding public charging networks. These charging services, along with software updates and new features integrated into EVs, further differentiate service offerings in the industry. Furthermore, range, battery life, and charging speed are critical factors that influence consumer choices and represent key service characteristics that differentiate between EV models and manufacturers.

There are considerable barriers to entry into the electric vehicle industry. One of the most prominent challenges is the high capital investment required to develop and manufacture EVs, particularly because of the need for significant investments in research and development (R&D) for battery technology, electric drivetrains, and software integration. Companies need access to large amounts of capital to establish production facilities, design efficient supply chains, and invest in marketing and distribution. The technological expertise required to innovate in areas such as battery chemistry, powertrain engineering, and EV software development also poses a significant barrier to new entrants (Çolak & Irmak, 2023). Moreover, the EV industry benefits from economies of scale, meaning that larger firms with established production capabilities can produce vehicles more efficiently and at a lower cost per unit than smaller firms, thus restricting the ability of new companies to compete on price. Regulatory compliance is another key barrier, as governments around the world enforce strict emission standards and provide incentives for both manufacturers and consumers. While these incentives help stimulate demand for EVs, they can also create complexities for smaller players, who must navigate different regulatory environments in multiple markets.

Brand loyalty and consumer trust also act as barriers to entry into the electric vehicle market. Established automakers benefit from decades of brand recognition, which creates consumer confidence in the quality, reliability and safety of their products. New entrants face the challenge of building their reputation from the ground up and gaining consumer trust, especially regarding the perceived risk of new and untested technologies in the realm of EVs. Chinese EVs achieve five-star ratings in Euro NCAP crash tests, better than some European premium EVs (Euro NCAP, 2023); perhaps safety will be a tool to convince customers to buy EVs from Chinese carmakers.

The dynamics of pricing in the EV industry is fragmented when it comes to controlling prices. While large companies, such as Tesla and Volkswagen, wield considerable influence over prices due to their established market presence, technological innovations and economies of scale impact significantly on prices. As battery technology improves and the cost of batteries decreases, manufacturers are gradually gaining more flexibility to adjust prices and produce more affordable vehicles, thereby broadening market accessibility. Some manufacturers (e.g., Renault) have bolstered this effect through battery leasing. However, pricing strategies differ significantly across regions, as some markets offer government incentives and subsidies while others do not. The Union's regulatory framework, including initiatives such as the European Green Deal and CO_2 emission standards, has played a significant role in accelerating the adoption of EVs in Europe (Lazaroiu et al., 2023). These policies have made Europe one of the fastest-growing regions in terms of EV sales. Consequently, companies may adjust their pricing strategies based on local policy environments and the level of competition in each market. By contrast, China, the largest market for EVs, benefits from a strong domestic manufacturing base and government incentives, enabling companies such as BYD to offer more competitively priced EVs. These pricing dynamics are further influenced by the growing number of companies involved in expanding the charging infrastructure on a global scale. Consumers now face varying costs depending on whether they use private or public charging stations with different pricing models. As more charging stations become available, particularly in Europe and China, the accessibility and affordability of EVs will continue to evolve, driving further growth in this sector. However, Europe's EVs face higher production costs than their Chinese counterparts, which is due to stricter regulatory requirements and reliance on imported components may lead to higher prices compared to markets such as China (Miran, 2024). To fight for market share in the face of fierce competition from local manufacturers, Volkswagen was forced to lower the prices of their EVs on the Chinese market (Ziye, 2024); BMW experienced the same with its electric Mini Cooper. This clearly exposes the differences in production costs.

The European EV market remains highly concentrated, with a few dominant players controlling the majority of market share. Despite an influx of entrants, significant barriers to entry continue to limit competition, such as high capital investment, technological expertise, and supply chain complexity. However, the market's future is buoyed by continued government incentives, improved technology, and an expanding charging network. As the industry continues to evolve, the dynamics of market competition, pricing, and service offerings will reshape the EV landscape across Europe (Table 6.1).

Table 6.1. European market structure of EV industry

Feature	Description
Market structure	Oligopoly
Number of companies	A few large
Service characteristics	Differentiated
Barriers to entry	High
Control over price	Varies

Source: adapted from Coiacetto (2007).

6.3. Market efficiency

The concept of an efficient market originated in financial economics. In such markets, prices fully reflect all available information, ensuring that market prices adjust quickly and accurately to new data. This idea is most notably captured by the Efficient Market Hypothesis (EMH) (Malkiel, 1989). In such a market, prices are considered fair and mirror the true value of the assets. However, market efficiency can vary depending on the market structure. To assess this, three types of efficiency are examined: allocative, productive, and dynamic.

Allocative efficiency can be defined as the production of an optimal mix of goods and services by using the most efficient combination of resources. This involves selecting an output combination that consumers would choose in perfectly competitive markets, where prices accurately reflect the true costs of production (Inderst & Shaffer, 2009). Allocative efficiency occurs when production aligns with consumer preferences, meaning that the output mix maximises societal well-being (Gyrd-Hansen 2014). This is achieved when the price equals the marginal cost (P = MC) (Inderst & Shaffer, 2009).

The factors influencing productive efficiency are closely tied to the production process and resource allocation. On the other hand, productive efficiency focuses on producing goods or services at the lowest possible cost, enabling an economy to increase the output of one product without sacrificing the production of others (Bain, 1954). This efficiency is driven by economies of scale (Baumers et al., 2016), and analysts assess it to determine whether resources are being utilised optimally or whether there are inefficiencies hindering production capacity.

Finally, dynamic efficiency refers to the ability of an economy to adjust to changing conditions. It is assumed that increased investment fosters higher long-term output, leading to greater consumption (Geerolf, 2013). Achieving dynamic efficiency involves optimal rates of innovation, investment, and technology adoption, which enhances production processes and reduces long-term costs.

Table 6.2 provides a comparative overview of how these efficiencies are realised in market structures within the EV industry. The sign "+" indicates that the type of efficiency is achieved, while "–" means that it does not occur.

Table 6.2. EV market structure and efficiency types

Efficiency	Oligopoly
Allocative	– Price > Marginal Cost (MC)
Productive	+ Economies of scale possible for a few key players (such as BYD, Tesla)
Dynamic	+ High rates of product, process and technology innovation

Source: authors' elaboration.

In the EV industry, achieving allocative efficiency is a challenge because of the mixed market structure. Dominant oligopolistic players, such as Tesla, Volkswagen and BMW, have some price-setting power, yet they tend to set prices above marginal costs due to limited competition and differentiated products. This is typical of oligopolies, in which firms' ability to influence prices often results in prices being higher than those under perfect competition conditions. In more competitive segments of the market, such as emerging EV startups, prices may be closer to the marginal costs. However, these companies often struggle to gain market share from larger, more established players. Consequently, despite increased competition in some areas, consumers may still face higher prices for vehicles or services and may not have access to the optimal quantity of EVs at competitive prices.

Productive efficiency in the EV market is largely driven by economies of scale, particularly among large firms in oligopolistic markets. Major players can spread their fixed costs across a large volume of EVs, benefiting from reduced average costs per unit. For example, companies investing heavily in battery production or assembly line automation can reduce their manufacturing costs over time. However, smaller players or startups struggle to achieve similar economies of scale and may face higher per-unit production costs, making it difficult for them to compete on price or efficiency. Without the ability to leverage economies of scale, these smaller companies often find it challenging to compete with larger players that dominate the market.

Regarding dynamic efficiency, oligopolistic markets tend to perform better than monopolistic markets because competition between major players encourages continuous innovation and the adoption of new technologies, all of which

are crucial in this market. In the EV sector, firms such as Tesla and Volkswagen maintain their competitive edge by investing heavily in cutting-edge technologies, including battery efficiency, range, and autonomous driving features. In oligopolistic markets, competitive pressure and financial commitment to R&D drive the rapid development of critical technologies such as battery advancements and charging infrastructure, which are essential for the widespread adoption of EVs.

Conclusions

This study explores the EV industry's market structure and its influence on various forms of market efficiency. The key findings highlight that the EV market operates within a mixed-market structure, blending oligopolistic and competitive elements. The industry is characterised by a few large firms, such as BYD, Tesla, and Volkswagen, which dominate the market and create an oligopoly. This structure is evident because of differentiated services, in which major players leverage technological innovation and branding to maintain a competitive edge. Barriers to entry are high because of the significant capital investment required for manufacturing, R&D, and infrastructure establishment, which in turn hampers new entrants' ability to compete. Additionally, control over price varies, as larger firms can leverage economies of scale and market power; however, prices may also be affected by technological advancements and regional market conditions.

Allocative efficiency remains difficult to achieve in this oligopolistic structure because the limited competition enables dominant firms to set prices above marginal costs. However, productive efficiency is achieved through economies of scale and dynamic efficiency is driven by competitive pressure between major players, leading to continuous innovation and investment in R&D. Despite the rapid growth of the EV market, ICE vehicles continue to dominate because of their price advantages and the established infrastructure supporting them.

This study underscores the importance of government policies, particularly incentives, subsidies, and regulations, in supporting the transition to EVs and promoting market competition. These policies have been crucial for driving the adoption of EVs by making them more affordable and accessible to consumers. However, on the other hand, some EU regulations could potentially restrict growth in the market and lead to higher costs, making EVs less competitive and less attractive to consumers. For instance, strict regulatory requirements for manufacturing, emissions standards, and higher cost of compliance with environmental regulations can drive up manufacturers' production costs. This,

in turn, could result in higher prices for consumers, making EVs less financially viable for some segments of the market and potentially slowing the transition to electric mobility.

The implications for the future point to the need for continued innovation in battery technology and charging infrastructure to make EVs more usable, affordable, and accessible. Additionally, governments should streamline regulations and support smaller market entrants to foster competition and lower prices.

With the entry of Chinese carmakers, competitive dynamics in the European EV market are changing. As the EV market continues to grow, government policies, technological innovations, and increased competition play key roles in shaping the industry's evolution, particularly in terms of how effectively the market can achieve greater efficiency and sustainability.

Further research could explore the long-term impact of government policies on the global EV market, particularly in emerging markets, and investigate how charging infrastructure and technological advancements shape future market dynamics. It would also be beneficial to study the potential role of autonomous EVs in market transformation, and how consumer behaviour may evolve as electric mobility becomes more integrated into daily life.

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