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Economic Analysis of Electric Vehicle Manufacturers: a Comparative Study

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This study investigates the market dynamics of Tesla and NIO in the electric vehicle (EV) industry, with a focus on NIO's innovative Battery as a Service (BaaS) model and its pricing strategy. While NIO's competitive pricing attracts buyers, the study reveals that its low vehicle and battery prices negatively impact profitability. The research also identifies NIO's recent market share decline and the challenges posed by its pricing model. From a sustainability perspective, the study highlights the significant freshwater usage in the manufacturing processes of both Tesla and NIO, stressing that this places a strain on local water resources. To contribute meaningfully to emission reduction, the optimization of water recycling and energy efficiency in manufacturing is crucial. The analysis provides insights into NIO's declining market share and offers suggestions for future market participation.

1. Introduction

The automotive industry has witnessed significant transformations in recent years. As the world shifts towards a more sustainable future, EVs have emerged as a promising alternative to traditional combustion engines. This resulted in more EVs being sold in China in 2021 (3.3 million) than in the rest of the world in 2020. Additionally, China is now home to numerous EV manufacturing companies, and there are nearly 300 different Chinese EV models (e.g. BYD, NIO, ORA, XPENG, XIAOMI, ZEEKR) available in the automotive market (Reddy and Radmore, 2023). Market competition and innovation in the field of EVs have opened up space for these Asian OEM companies, significantly influencing the competitiveness of companies from other continents. The study provides a theoretical framework by examining the reasons why one emerging Chinese brand, the NIO Startup company, has gained a competitive position against Tesla, which has been considered the leading EV brand over the past 10-15 y. NIO was chosen because, in addition to offering chargeable vehicles, the company also provides Battery Swap options, which can have a significant impact on vehicle purchasing decisions. Among the major players in the EV market, both NIO and Tesla have gained substantial attention and market share. This manuscript aims to provide a brief comparison of the economic and sustainable performance of these two innovative companies. The study examines critical indicators such as revenue and profitability; it delves into market data and potential prospects and challenges for both companies. By analyzing financial statements, this manuscript intends to contribute to the existing knowledge of the economic landscape of the automotive industry. The findings of this study can shed light on the contrasting approaches and performance of NIO and Tesla in the EV market.

1.1 Literature Review

During the literature review, the emphasis was placed on examining the available scientific sources and reports, which are accessible in the official databases of Tesla and NIO. In the first chapter, the focus is on the market performance of Tesla and the comparison of sales prices based on available data, which also considers the selling prices of different capacity batteries in the vehicles. Afterward, by utilizing the available results of the NIO company, a potential Asian competitor, the similarities and differences between the two companies are revealed based on fundamental sources of information.

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1.2 Methodology and Data

The results of the factories specializing in the production of EVs have been extensively debated. Questions include whether EVs can take the lead in future vehicle sales and which manufacturers could become competitors to Tesla. To accomplish this, existing analyses are compared, primarily focusing on the number of units sold and the resulting revenue. The main sources referenced in the analysis are shown in Table 1. Both Tesla and NIO reports were used to track the market data of the companies.

Table 1: Overview of data source used for the analysis

Document Type	Period	Reference	Used data
- Tesla Vehicle Production & Deliveries	Q4/2018-Q4/2019	Tesla, Q4 2019	Sales data
- Tesla Vehicle Production & Deliveries	Q1/2020-Q1/2021	Tesla, Q1 2021	Sales data
- Tesla Vehicle Production & Deliveries	Q1/2021-Q1/2022	Tesla, Q1 2022	Sales data
- Tesla Vehicle Production & Deliveries	Q2/2021-Q2/2022	Tesla, Q2 2022	Sales data
- NIO Inc. Reports Unaudited Q4 2019	Q1/2018-Q4/2019	NIO, Q4 2019	Sales data
- NIO Inc. Reports Unaudited Q3 2020	Q4/2018-Q3/2020	NIO, Q3 2020	Sales data
- NIO Inc. Reports Unaudited Q1 2020	Q1/2019-Q1/2020	NIO, Q1 2020	Sales data
- NIO Inc. Reports Unaudited Q2 2021	Q3/2019-Q2/2021	NIO, Q2 2021	Sales data
- NIO Inc. Reports Unaudited Q4 2021	Q1/2020-Q4/2021	NIO, Q4 2021	Sales data
- NIO Inc. Reports Unaudited Q2 2022	Q3/2020-Q2/2022	NIO, Q2 2022	Sales data
- NIO ESG Report, 2021	2021	NIO ESG Report, 2021	Environmental data
- NIO ESG Report, 2022	2022	NIO ESG Report, 2022	Environmental data
- NIO ESG Report, 2023	2023	NIO ESG Report, 2023	Environmental data
- Tesla Impact Report, 2018	2018	Tesla Impact Report, 2018	Environmental data
- Tesla Impact Report, 2023	2023	Tesla Impact Report, 2023	Environmental data
- 2023 E.V.M. Intelligence Report	2023	Reddy & Radmore, 2023	Global data
- Model S Premium Electric Sedan	2015	Tesla Model S, 2015	Car specifications
- Tesla © 2024. Charging	2024	Tesla Charging, 2024	Charging data

For Tesla, the number of units sold at the model level was trackable on a quarterly basis. However, during the data collecting for NIO, we faced challenges such as the unavailability of model-level breakdown for the sold vehicles. Therefore, in this case, only the total number of units sold was known. There was a single mention of the number of units sold per model in the second quarter (2022) of NIO's Report, which provided the basis for finding the optimal estimation of battery sales. The sales prices of the vehicles and the battery prices derived from these sales prices could only be accessed through other data sources, which also made data collection more difficult.

1.3 Tesla and NIO

Under the leadership of Elon Musk, the Tesla company has positioned itself at the forefront of the EV industry and has become a global leader in the development and production of EVs. For example, in Q1 2022, they delivered 310,048 vehicles, representing a significant jump compared to the 184,877 vehicles delivered in Q1 2021. This resulted in automotive revenue of $16.86 billion, indicating an 87 % growth compared to Q1 2021. As mentioned in Tesla's financial reports, the company attributed this to higher selling prices of the models (Tesla, Q1 2022). The following Figure 1 illustrates the Tesla sales prices from 2022 to 2023, as well as the prices for Q1 and Q2 of 2024 (represented by the solid columns), along with the derived battery purchase costs per model (represented by the gray columns) based on available data. The sales data for Tesla vehicles comes from more than 100 monthly data points, which may have changed several times within the past few months. The four examined models are the Model S (sports sedan with 85 kWh battery), Model X (urban crossover with 100 kWh battery), Model 3 (sedan with 75 kWh battery), and Model Y (urban crossover also with 75 kWh battery). The accuracy of the data delivered by Team skills.ai (2024) has been verified through plausibility checks, where a sample of the realized sales amounts for a given model and year/month were randomly selected and examined. According to the diagram, it is common for the battery price of the vehicles to account for approximately 50 % of the vehicle's sales price, which is particularly evident in models equipped with smaller capacity (75 kWh) batteries. Additionally, higher-priced vehicles in the Tesla Model S and Model X range showed a significant increase in sales revenue in 2022, possibly due to a semiconductor shortage during that period. This prompted the company to strive for comparable revenue to previous years in the annual corporate balance sheet. Thanks to favorable loans offered during the COVID-19 pandemic, potential buyers opted for vehicles in the slightly higher price range instead of lower-priced ones. This also allowed the company to increase the sales price of the vehicles. In 2022, Tesla began production and delivery in their new factory located in Berlin-

Brandenburg, Germany, in March, followed by the commencement of production in their Texas factory in April (Root, 2024).

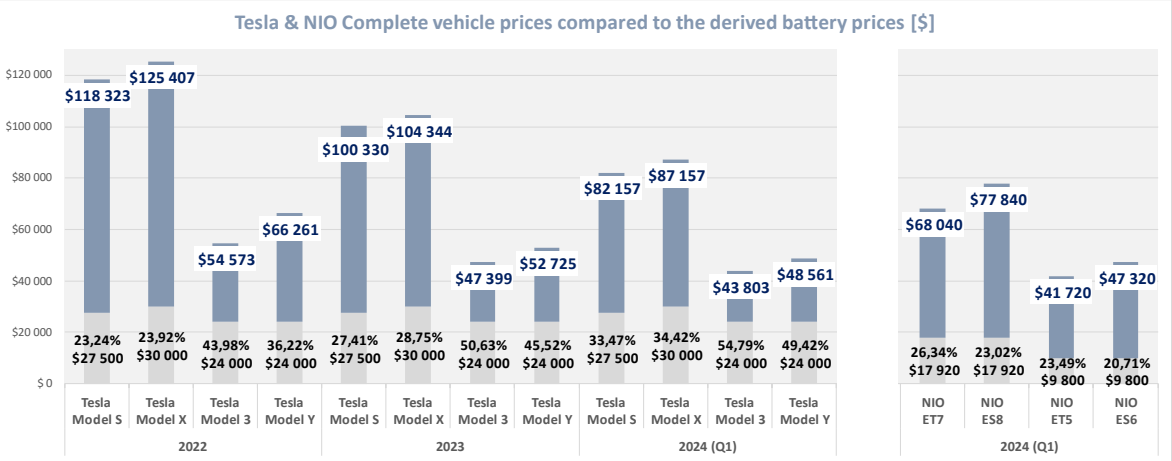

Figure 1: The sales prices of selected Tesla & NIO models, and the battery prices derived from the sales prices, Tesla data: (Manansala, 2023; Tesla Model S, 2015; Senn-Kalb and Mehta, 2022; ©2024 EV Database, 2024a; ©2024 EV Database, 2024b; Lu, 2023; Team skills.ai, 2024); NIO data: (NIO ET5, 2023; Zhang, 2024)

The opening of these two new manufacturing facilities reduced the pressure on Tesla's Shanghai factory and allowed for more efficient management of supply chain challenges compared to their competitors. These challenges stemmed from the mentioned chip shortage and raw material shortages for batteries (Root, 2024). The main source of revenue for the NIO company comes from vehicle sales, which accounts for more than 90 % of its total revenue (Pisano et al., 2023). NIO's sales prices and battery costs for models comparable to Tesla's (available from Q1 2024) are shown on the right side of *Figure* 1. The NIO ET7 has a similar body structure and specifications to the Tesla Model S, the ES8 matches the Model X, the ET5 competes with the Model 3, and the ES6 aligns with the Model Y. All four NIO models are available with both 75 kWh and 100 kWh battery capacities. In the diagram, the ET7 and ES8 are shown with a 100 kWh battery, while the ET5 and ES6 have a 75 kWh battery. This choice aligns with the performance levels of their corresponding Tesla counterparts. In the smaller battery capacity version of the ET7 model the price of the vehicle is approximately 12 % more favorable compared to the one shown in the diagram. The battery cost for this version is estimated to be 9,800 $, contrasting with the 17,920 $ shown in the diagram. The sales prices follow a similar pattern for all four NIO models, in terms of both the complete vehicle and the batteries, considering the battery capacity. The sales prices of NIO batteries only account for approximately 27 % of the total vehicle purchase price (in the case of a vehicle equipped with a 100 kWh battery), while under the most favorable configuration, the 75 kWh energy storage system represents only 20-24 % of the total vehicle sales price.

This represents a significant discount, which is evident in both NIO and Tesla vehicle prices (NIO ET5, 2023); (Zhang, 2024). The NIO offers a unique opportunity for the user to replace the battery rapidly instead of charging the vehicle. The Battery Swapping Station (BSS) technology was first introduced in 2018 (Shenzhen). It has undergone continuous development, and by 2023, it will have reached the third-generation level of maturity. Currently, there are over 2100 NIO BSSs worldwide, with 43 stations operating in Europe (Germany, Norway, Netherlands, Sweden and Denmark). The third generation BSS can accommodate 21 batteries at once, compared to the second generation's capacity of 13 batteries, despite having the same footprint. Additionally, the third-generation system functions as a natural energy storage facility. The combined capacity of the 21 batteries is 2,100 kW, which is utilized for charging the batteries at night and swapping them during the day, reducing the load on the grid. In the absence of a power supply, the system contributes to balancing electricity generation and consumption (NIO, 2024). After the battery swapping (BS) process, the station performs a comprehensive inspection of the replaced battery. If the technical inspection determines that the battery is not in the appropriate condition, it is removed from the flow of the BS system and sent for servicing. The advantage of this system is that the degradation of the battery does not directly affect the vehicle's lifespan for the user if they choose the BS service supplemented with Battery as a Service (Tycorun Energy, 2023).

2. Analysis Results: Tesla and NIO

The aim of the following chapter is to give a brief analysis of the competitiveness of the two main EV companies. *Figure* 2 illustrates the quarterly vehicle sales of Tesla (dark blue columns) and NIO (light blue columns), which are compared with the revenues (green line) and costs (orange line) derived from vehicle sales, broken down per vehicle on average.

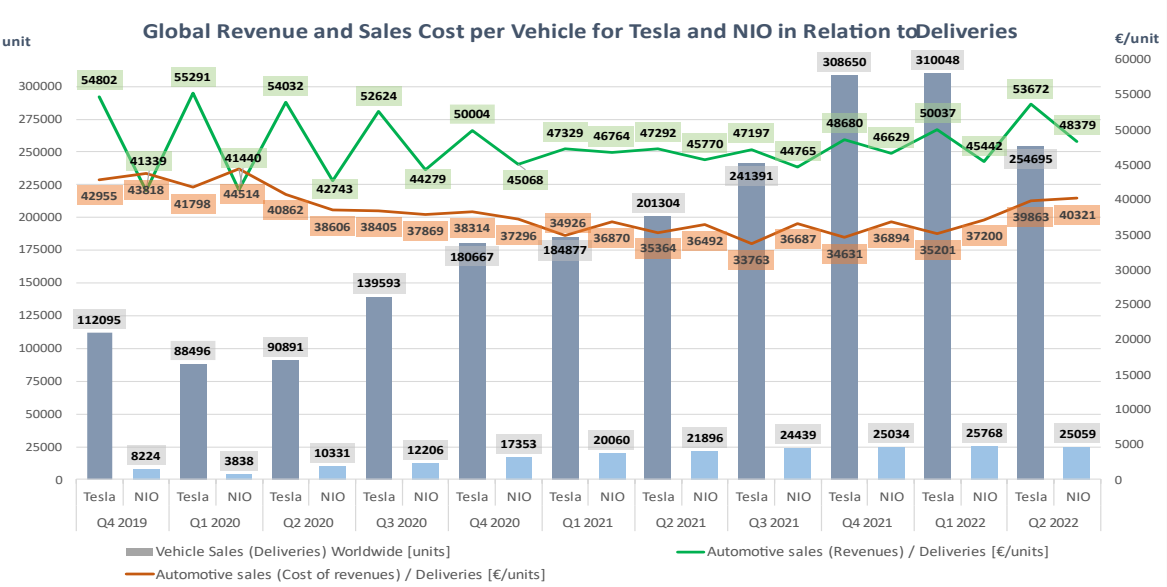

Figure 2: Revenue and Cost of Revenue for Automotive Sales in Relation to Quarterly Deliveries of Tesla and NIO Models (Tesla, Q4 2019; Tesla, Q1 2021; Tesla, Q1 2022; Tesla, Q2 2022; NIO, Q4 2019; NIO, Q4 2021, NIO, Q2 2022; NIO, Q1 2020; NIO, Q3 2020; NIO, Q2 2021)

The data shows that NIO initially sold its vehicles at a higher cost than the revenue generated, especially during the lower volume periods. However, after surpassing 10,000 units sold (Q2 2022), this trend reversed, and a positive growth is observed as the gap between cost and revenue widened. On the other hand, Tesla demonstrates stable performance in terms of both units sold and revenue and cost per vehicle during the same periods, thanks to its earlier production start and greater brand recognition. The average revenue and cost per vehicle over the analyzed period shows that Tesla's revenue per vehicle is approximately €13,171, while NIO's is around €6,005. This implies that NIO is selling its vehicles at about half the price of Tesla's for similarly platformed models. In the following section, the focus will shift to the annual water consumption of the produced cars by NIO and Tesla. Due to the continuous increase in demand for EVs, companies are using an increasing amount of freshwater in their vehicle manufacturing processes, with specific data provided in *Figure* 3.

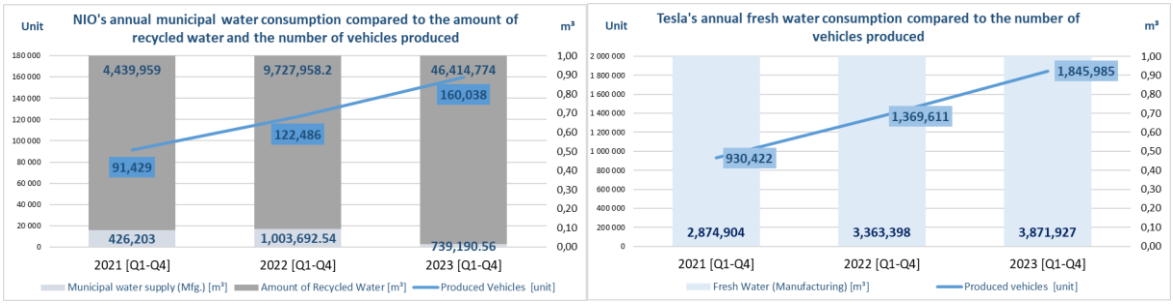

Figure 3: Comparison of water consumption in the manufacturing process as reported by NIO and Tesla (NIO ESG Report, 2021; NIO ESG Report, 2022; NIO ESG Report, 2023; Tesla Impact Report, 2018; Tesla Impact Report, 2023)

As shown in the figure, NIO (left chart) nearly tripled its municipal water demand in 2022 compared to 2021, while the amount of recycled water more than doubled. This can be explained by the opening of NIO's First

Advanced Manufacturing Center (NIO F1) with a new paint shop, as well as the launch of operations at NIO's Second Advanced Manufacturing Center (NIO F2) (NIO ESG Report, 2022). The company attributes the nearly five-fold increase in recycled water usage in 2023 to the expansion of environmental data collection, with the opening of the E0 and E1 facilities, which are the Nanjing Tooling Trial Shop, Nanjing Battery Pack Production Shop, and Hefei Power Products Plant. Additionally, the company cites the increased demand for sold vehicles, although this proportional increase is still 1.89 % lower compared to the 2021-2022 period in terms of vehicles produced between 2022-2023. If we only consider NIO's municipal water consumption, the annual municipal water usage per vehicle was 4.66 m³/vehicle in 2021, 8.19 m³/vehicle in 2022, and 4.62 m³/vehicle in 2023. Regarding Tesla's results (right chart, *Figure* 3), no data was available on the amount of recycled water used by Tesla, so fresh water consumption and the number of vehicles produced each year were used as reference points. The results for the examined period show that Tesla's vehicle manufacturing processes are much more stable compared to NIOs in terms of freshwater usage. The estimated water consumption per vehicle was 3.09 m³/vehicle in 2021, 2.46 m³/vehicle in 2022, and 2.10 m³/vehicle in 2023 (Tesla Impact Report, 2023). The freshwater consumption per vehicle, according to the Tesla Impact Report (2018), shows a three to fourfold decrease during the 2021-2023 period compared to the 8.77 m³/vehicle recorded in 2017.

3. Conclusion

The contribution of this study lies in identifying NIO's unsustainable business model due to its low pricing strategies, particularly in vehicle sales, and then highlighting the significant water consumption and the potential impact of the BaaS (Battery as a Service) model. The study compared the sales data of EV developers and manufacturers, as well as Tesla and NIO. The results show that NIO's market model faces significant disadvantages due to overly favorable vehicle pricing, which makes NIO's business model unsustainable based on the available data. It is important to emphasize that the full vehicle price of NIO is, on average, 1.31 times that of the battery-less model, compared to 1.61 for Tesla, which was broken down at the model level. The study highlights a problem in NIO's competitive market, pointing to why the company generated a loss of more than $424 million in Q2 2022 alone, based on the available data. One reason for this is the extremely favorable pricing of both the battery and the full vehicle, which makes the company attractive to potential customers but hinders profitability. At the same time, NIO's innovative BaaS offering allows customers to purchase vehicles at a favorable price without a battery, with the option to rent one. Other factors include manufacturing advantages in China, which the study did not address but are significant in terms of lower production costs, particularly in labor and supply chain. The government in China actively supports the electric vehicle market and local manufacturers, which helps reduce the company's production costs. Moreover, NIO operates as a local player in China, supporting the domestic market, while Tesla sells its products and services globally. This local focus allows NIO to respond more flexibly to market changes and consumer demands. As a further development of the study, it would be worthwhile to analyze where the cost optimum lies in vehicle pricing, which could enable NIO to become profitable. It would be valuable to break down by model what sales volume would allow the company to operate without reporting a loss in its quarterly statements. In connection with sustainability, it also requires examination as to how the company could optimize its production processes to minimize freshwater consumption, protecting one of the environment's most valuable natural resources. In summary, NIO's low-pricing strategy opens up research gaps that warrant further investigation. These could include strategies such as reducing production costs as output scales, improving operational efficiency, or even diversifying revenues. Another important point regarding NIO's competitiveness is whether the BSS service, due to the technical demands of continuous battery swapping, can operate sustainably, supporting the company's environmental, economic, and technical goals.

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