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DEVELOPMENT OF THE ELECTRIC VEHICLE MARKET WITH A FOCUS ON SUSTAINABILITY

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ABSTRACT

In recent years, the global transportation sector has witnessed a shift towards electric vehicles powered by renewable energy sources. Experts predict an increasing role for electric vehicles in leading economies due to the depletion of fossil fuels and the harmful emissions from internal combustion engines. The rise in energy prices and stringent environmental regulations further drive this transition. The main goal of the research work is to study the relationship between the production of electric cars, government subsidies, oil prices, GDP per capita and R&D investments. Correlation analysis was chosen as the main method, but a graphical method was also used for visualization. There is a strong positive correlation between the production of Tesla electric cars and the price of oil, indicating that higher oil prices make Tesla electric cars a more attractive, cost-effective, and environmentally friendly alternative to gasoline and diesel cars. Based on the conducted analyses, it can be emphasized that the global transition to the production and use of electric vehicles is a critically necessary response to climate change, the reduction of fossil fuel reserves, and the growing need for sustainable development. This transition helps increase energy efficiency, reduce dependence on oil, and improve air quality in cities by reducing emissions of harmful substances.

Keywords: EVs, transport, sustainability, CO2 emissions, automotive industry

JEL Classification: C3, Q5, R4

INTRODUCTION

In recent years, a noticeable trend in the development of world transport has been the gradual transition to the use of electric transport with the involvement of renewable energy sources. Many experts claim [1; 2; 3] that the role of this type of transport in the economy of leading countries will only increase over time. The reasons for this are the depletion of used fossil fuels in traditional car models and the harmful emissions that enter the atmosphere because of the operation of cars with internal combustion engines. Depletion of fossil fuel reserves causes energy prices to rise and gradually increases the cost of using traditional cars. In addition, high environmental requirements for CO2 emissions and other greenhouse gases, which are applied in many countries around the world, increase the cost of operation of traditional vehicles [4].

Today, based on the introduction and development of environmentally friendly electric vehicles, renewable energy technologies are an example of a tandem capable of solving environmental, economic and energy problems, as well as promoting the ecological modernization of national economies.

LITERATURE REVIEW

Electric vehicles have become a significant factor in the automotive market in recent years, offering an alternative to traditional fossil fuel-based vehicles. Their distribution and integration into everyday life play an important role. One of the key benefits of electric cars is reducing environmental pollution. The use of electric vehicles significantly reduces the emission of carbon dioxide and other harmful emissions, which contributes to the improvement of air quality and the fight against global warming. This has a direct positive impact on the health of the population, especially in urban agglomerations, where the level of air pollution is traditionally higher. Electric cars are considered a significant step in the direction of environmentally friendly transport, offering an alternative to traditional cars that run on gasoline or diesel. They have the potential to reduce air pollution and greenhouse gas emissions, two major environmental challenges facing the modern world. Also, electric cars operate much more quietly than cars running on diesel or gasoline fuel, which reduces the level of noise pollution, especially in urban agglomerations.

Electric cars are called the transport of the future, which do not require fuel. They replace traditional internal combustion engines with more efficient electric motors, which leads to a reduction in exhaust gases. However, it is impossible to call them 100% safe for the environment, and disputes about this do not subside. To talk about how environmentally friendly electric cars are, you should know their carbon footprint. Considering all aspects of the resulting carbon footprint, experts are of the opinion that an electric car becomes more ecological only after the first 30-40 thousand km of mileage [5]. At the same time, both supporters and opponents agree that the main purpose of electric cars is to improve air quality in megacities [4; 6]. Electric vehicles are a symbol of environmental awareness and technological progress, prompting individuals to rethink their transportation habits. It also indicates the existing need for the development of infrastructure to ensure the charging of electric vehicles, which requires joint efforts from the state authorities, local organizations and businesses. It is also impossible to ignore the impact of electric vehicles on the countries' security by reducing dependence on imported fossil fuels, countries have the opportunity to develop domestic sources of renewable energy, which contributes to the creation of more sustainable and secure energy systems.

The study [7] aims to quantify the economic impact of using electric versus petrol-fueled private cars on public finances within a country. By developing an integrated valuation method based on input-output analysis, the study considers manufacturing and usage stages, fiscal effects, and social contributions. The results show that the impact on public finances is significant, with social contributions from production being the major revenue source. The papers [8; 9; 10] aim to explore the trends and concentration of electromobility in European Union (EU) countries, particularly following the economic impact of the COVID-19 pandemic. The study found that the pandemic, while affecting the economic conditions of all EU countries, did not slow down but rather accelerated the adoption of electric vehicles, with the growth rate increasing significantly from 48% in 2019 to 86% in 2020, driven by changes in social behaviour and mobility patterns. The study [11] develops a model using system dynamics and agent-based approaches to evaluate the transition's impact on automotive supply chains and stakeholders, emphasizing the need for circular economy principles to achieve net-zero goals. While the transition can create new business opportunities and increase competitiveness, it also poses challenges, particularly in reducing manufacturing jobs, necessitating policies to support workforce reskilling and relocation.

Increasing the number of electric vehicles requires more electricity [12] (Figure 1).

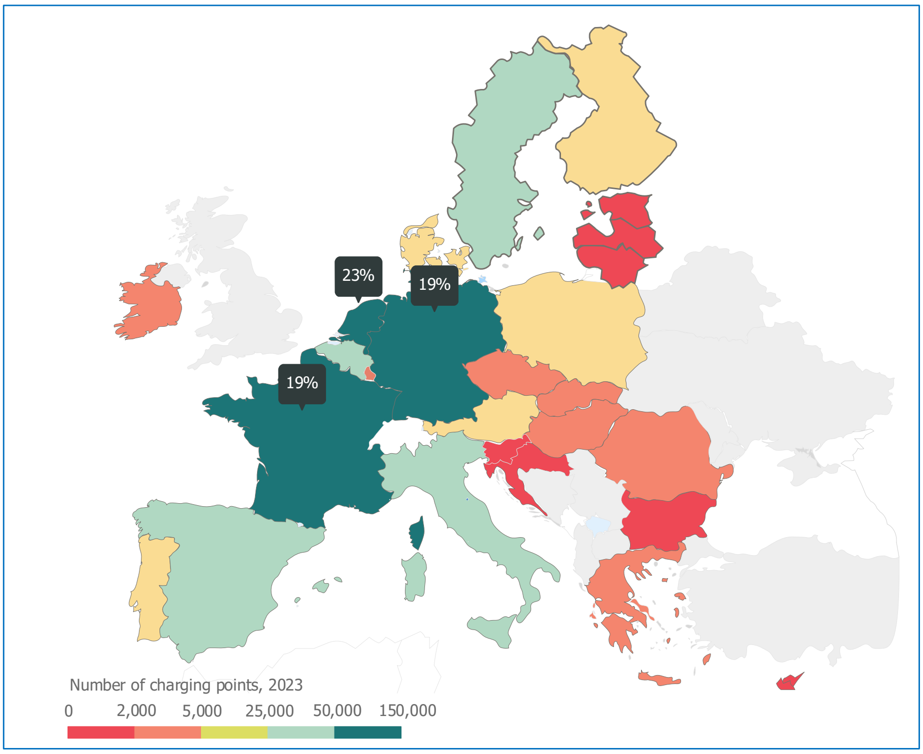

Figure 1. Distribution of electric car charging points across the EU. *(Source: [14])*

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This incentivizes governments and energy companies to upgrade and expand electricity grids, including implementing smart grids and increasing electricity generation from renewable sources such as solar and wind power. Many states introduce tax breaks, subsidies, and other incentives to make the purchase and operation of electric vehicles more attractive. This can include reduced purchase taxes, free parking, access to public transit lanes, and more [13]. In the world, most states encourage their citizens to buy electric cars, they additionally provide them with various insurance options. For example, they give a spare battery for a car or 1 year of free maintenance of various technical parts. Countries can also pay a certain amount to citizens for buying a car.

Strategic planning for long-term sustainability: companies must navigate the complexities of technological advancements, regulatory in recent years, the automotive industry has garnered significant attention from research experts and practitioners due to growing concerns about climate change [15; 16]. This heightened awareness has given rise to several approaches, including the concepts of sustainable development (SDG), environmental social management (ESG), and corporate social responsibility (CSR). Currently, manufacturing companies face several key challenges (Figure 2):

1. Changes, and evolving consumer preferences to ensure long-term sustainability.
2. Sustainability vs. cost-effectiveness: firms often encounter a trade-off between implementing environmental practices and achieving cost-effectiveness.
3. Consumer expectation satisfaction: there is a growing demand for transparency and trust in sustainable development initiatives, which companies must address to meet consumer expectations.
4. Standards-based environmental responsibility and risk assessment: adhering to established standards for environmental responsibility and conducting thorough risk assessments are crucial for companies.
5. Supply chain complexity: each element of the supply chain has its unique environmental impact, adding to the overall complexity of managing sustainability.
6. Data availability and quality: comprehensive data covering all processes, from raw material extraction to production, transportation, and disposal, is essential for effective management.
7. End-of-life disposal: minimizing the environmental impact of product disposal at the end of their service life remains a significant challenge.
8. Carbon emissions: the industry’s carbon footprint, including emissions into the air, water, and soil, is a critical area of concern.

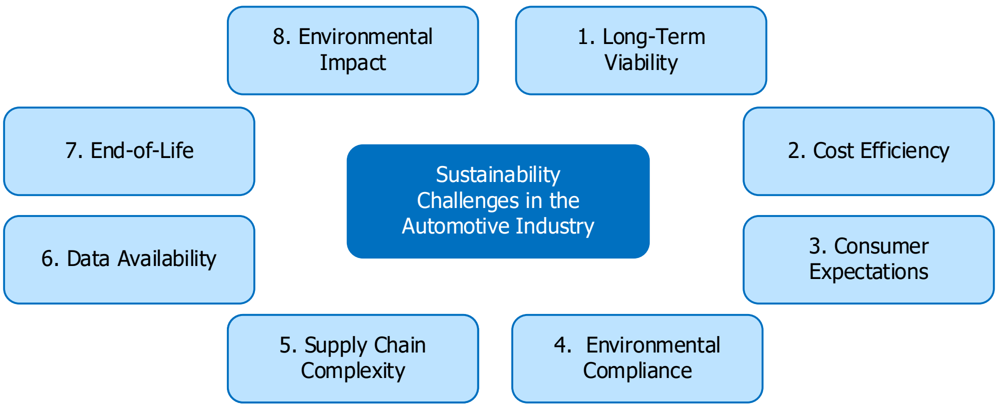

Figure 2. Sustainability in the automotive industry. *(Source: [17])*

These challenges necessitate a multifaceted approach, combining strategic planning, transparency, and rigorous environmental management to advance sustainability in the automotive industry.

In discussing the trends in the development of the automobile market, researchers identify several key areas [17; 18; 19; 20]:

1. Electric vehicle (EVs) revolution: this trend is driven by advancements in battery technology, facilitating the growth and adoption of electric vehicles.

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2. Hybrid technologies: these technologies offer enhanced fuel efficiency and reduced emissions, contributing to more environmentally friendly transportation options.
3. Circular economy practices: emphasizing recycling, reusing, and reducing waste throughout the production cycle, these practices aim to create more sustainable production processes.
4. Carbon neutral initiatives: these initiatives encompass efforts to reduce the carbon footprint of car manufacturing, as well as emissions from upstream supply chain processes and downstream life cycle phases such as distribution, use, and end-of-life.
5. Smart and sustainable materials: the development and use of bio-based plastics, recycled fabrics, lightweight composites, and other smart materials contribute to the sustainability of the automotive industry.
6. Shared mobility and connectivity: these concepts aim to reduce the overall number of vehicles on the road and promote the development of smart transportation systems.
7. Regenerative braking and energy recovery: these technologies are part of the broader search for sustainable and energy-efficient transportation solutions.
8. Digital transformation: utilizing Artificial Intelligence (AI), the Internet of Things (IoT), and Digital Twins, this transformation leads to predictive maintenance, optimized energy usage, and minimized waste.

These trends collectively indicate a significant shift towards sustainability, efficiency, and innovation in the automotive industry.

AIMS AND OBJECTIVES

The primary aim of this study is to analyze the economic and social factors influencing the production and adoption of electric vehicles (EVs), with a specific focus on the role of Tesla as a leading EV manufacturer. The objectives include examining the correlation between key variables such as oil prices, GDP, R&D investments, and government incentives on Tesla's production, evaluating the advantages and challenges of EVs in global and Ukrainian markets, and exploring strategies to enhance EV affordability, infrastructure, and innovation for sustainable development.

METHODS

Correlation analysis was chosen as the main method to identify and measure the relationships between Tesla's production and various factors such as oil prices, GDP, R&D investment, and government incentives. This method allows the examination of how these factors influence Tesla’s production and the broader EV market. Regression is referenced indirectly in the correlation analysis and subsidy-related data, focusing on the strength of relationships between subsidies and EV adoption metrics. Comparative analysis was used to compare traditional gasoline vehicles (e.g., Skoda Octavia A8) and electric vehicles (e.g., Nissan Leaf S) in terms of purchase price, maintenance costs, and long-term operational expenses. A cost-benefit analysis was used to evaluate the financial and operational costs of EVs compared to traditional vehicles, including subsidies, battery replacement costs, and maintenance expenses over a period of time. Qualitative analysis was used to discuss social factors (e.g., demographic trends, environmental awareness, and public health concerns) and their influence on EV adoption. The data were obtained from open sources on the review of electric vehicle markets in the world [4; 13; 21].

RESULTS

In 2022 EVs sales exceeded 10 million. That resulted in more than 26 million electric cars roaming global roads in 2022, representing a 60% uptake from 2021 [22]. Support from the state is a decisive factor in ensuring the stability and development of, for example, Tesla. In the United States, this automaker benefits from government subsidies in the form of tax credits, in particular, USD 8,500 per unit of production (Figure 3).

Elon Musk’s innovative electric vehicle companies such as Tesla and SpaceX collectively received USD 4.9 billion in government benefits, including tax preferences and soft loans, of which USD 2.4 billion was allocated to Tesla itself. This amount includes USD 45 million from the US Department of Energy, write-offs of USD 517 million in loans and USD 1.3 billion tax credits from the state of Nevada as a reward for the construction of the Gigafactory [13]. Tesla has firmly

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established itself in the market of the premium segment of electric vehicles. Despite advances in making batteries cheaper, the cost of electric vehicles may become unattractive without the help of government subsidies compared to diesel or gasoline vehicles.

The given data in Table 1 shows that from an economic perspective, the world's leading countries encourage their population to purchase electric cars and switch to ecological energy. The main advantages of electric cars include a reduced operating cost per 100 km, no harmful emissions, high efficiency (89-95% compared to 20-45% in internal combustion engines), lower noise level and the ability to charge batteries at home.

Table 1. Subsidy-related metrics for electric vehicles across different countries around the world. *(Source: calculated based on [4; 23; 24])*

Country	Subsidy ratio to total price (%)	Total subsidy amount (USD)	One-time purchase subsidy amount (USD)
South Korea	29	20,954	12,350
Denmark	39	19,554	18,700
Norway	47	16,203	15,200
China	25	15,324	13,260
USA	19	10,560	8,500
Spain	4	7,542	6,320
France	22	7,250	7,120
Netherlands	15	6,120	4,450
United Kingdom	16	5,430	4,730
Japan	11	4,740	3,860
Germany	14	4,520	3,800
Sweden	13	3,230	3,820
Switzerland	8	2,320	2,500
Portugal	3	1,300	410
Italy	1	120	120

The problems and prospects of the production of electric vehicles in the world and in Ukraine are extremely relevant in the context of the global trend to reduce dependence on fossil fuels and the desire to reduce CO_2 emissions. Among the main problems of the production of electric cars in the world are the high cost of batteries, which significantly affects the final price of the car, the limited infrastructure of charging stations, which makes electric cars less attractive to consumers, as well as difficulties in ensuring a sufficient amount of electricity from renewable sources. Ukraine, in turn, faces similar problems: high import duties on electric vehicles and their components, as well as insufficient development of its own technologies and production capacities in this area. The prospects for the development of electric cars in the world and in Ukraine, in particular, remain as optimistic. The growing attention of governments and the private sector to the problem of climate change is stimulating investment in the development of advanced battery technologies that can provide greater efficiency and a longer life cycle at lower costs. The development of the infrastructure of charging stations and the strengthening of international cooperation in the field of standardization of charging processes should increase the attractiveness of electric cars for consumers. In Ukraine, the development potential of electric vehicles is also related to the ability to develop and implement its own innovative solutions, in particular, due to the high level of engineering potential and the availability of significant resources for the production of "green" energy. The increase in the number of electric cars on Ukrainian roads and the development of the domestic electric car market can be facilitated by initiatives to reduce the tax burden on the import of electric cars and their components.

Let's turn to the production prospects of the Tesla company, which is the leader in the production of electric cars [23]. Currently, the Tesla company faces a lack of new advanced battery technologies, and therefore spends a lot of time on analytical work, and prognoses for increasing competitiveness in the market. One of the promising solutions consists in the development of a new electrolyte, the stability of which is lacking at high voltages. The use of a graphene battery could significantly improve the performance of Tesla cars, increasing their range from the standard 417-539 km to 1000 km, while the charging time would be reduced to 5-10 minutes, provided that a powerful charger is used. The use of a graphene battery could solve two key problems not only for Tesla but also for other electric car manufacturers: limited range and long charging times. However, the commercialization of this technology will not happen soon.

Comparing the twin cars (Table 2) – the gasoline Skoda Octavia A8 and electric Nissan Leaf S, it can be seen that their bodies and mechanical elements are similar. The basic version of the electric car is almost no different from the full configuration of a gasoline car in terms of equipment. There is potential for savings in operating costs, especially in battery and electronics. Among the advantages of an electric car is a cheaper transmission and an electric motor, although other elements of the power unit are about 40% of the base price. With the price of batteries and electronics falling, the manufacturer's margin should increase. However, with reduced government subsidies in some countries, automakers will have to lower the base cost of cars to keep electric cars' sales stable, which could lead to lower profits. Such an analysis helps to better understand how the financial costs are distributed between these two types of vehicles in terms of USD.

The assessment of the growth potential of the electric vehicle market in Ukraine should be based on a comprehensive analysis that includes not only sales volumes but also the cost of owning and operating these vehicles. Based on the data (Table 2), the cost of covering a distance of 100 kilometres in an electric car is almost 13 times lower compared to a similar trip in a gasoline car. Considering the maintenance costs during the first 5 years, we estimate that the average maintenance for an electric Nissan Leaf S is about UAH 1,500, while for a gasoline Skoda Octavia A8, the average cost is about UAH 4,000. Thus, maintenance costs for electric car owners will be approximately 2.5 times lower.

Table 2. Comparative costs of a traditional car and an electric car, USD. *(Source: calculated based on [4; 23; 24])*

Cost elements	Skoda Octavia A8	Nissan Leaf
Costs excluding transmission, USD	13,000	13,000
Gearbox, USD	894	350
Internal combustion engine, USD	2,000	0
Electric motor, USD	0	1,200
Fuel supply and exhaust system, USD	550	0
Power and charging electronics, USD	0	3,600
Battery, USD	0	6,000
Other costs	9,106	6,350
Total, USD	25,550	30,500

The owners of these cars bear the same costs for such needs as washing, parking, insurance, etc., provided that the mileage is 75 thousand kilometres in 5 years (5*15 = 75) and there is no need for additional repairs for both cars, assuming price stability. For fuel and maintenance of the Skoda Octavia A8, you will need to spend UAH 285,300, or USD 7,277.83, for the Nissan Leaf S electric car, you will need to spend UAH 6,000, or USD 151.5. Taking into account the purchase price, the total costs for five years will be: for the electric Nissan Leaf S – USD 30,500, for the gasoline Skoda Octavia A8 – USD 25,500. At the same time, a gasoline car is one and a half times cheaper than an electric car, but ten times more expensive to maintain. Under current conditions, the costs of cars break even after about four years, or in the ninth year of their use. The Nissan Leaf S battery is not eternal, and over time, within 7-8 years, its capacity can significantly decrease, it will be necessary to replace it with a new one for USD 5000-6000, or a refurbished one for USD 1500-2000.

Taking into account the purchase of two new cars in Ukraine, the Skoda Octavia A8 wins in terms of economy, the difference is almost USD 5,000. Also, the purchase of the Chademo charging station, which costs an additional USD 1,500, is not included. It is also necessary to take into account the costs of heating in winter, which significantly reduces the autonomy of electric cars. However, electric cars have their advantages, for example, the possibility of installing a two-zone electricity meter to reduce the cost of charging at night and the profitable purchase of a used car. The most popular electric car Nissan Leaf S can be bought from the US for USD 20,000-22,000, with low mileage and minimal loss of battery capacity. Replacing multiple battery modules (usually 3-5) will cost USD 100-150 per module.

On the way to mass distribution of electric cars in Ukraine, there are a number of obstacles that must be overcome. In particular, the cost of owning a mid-range electric car is comparable to a premium car with an internal combustion engine, low charging rates do not compensate for the high purchase price, and insufficiently developed infrastructure in small cities and long charging times are obstacles. One of the possible solutions is to increase the number of fast charging stations and produce affordable electric cars for a wide range of consumers.

According to studies [25; 26], state instruments for stimulating the production and purchase of electric cars have a significant impact on the choice of this segment of cars by consumers compared to traditional ones. Table 3 shows that the greater the government subsidies for the purchase of electric cars, the stronger the relationship between the factors. Data

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for regression analysis are given in Appendices 1, 2 and 3. Every year, with the increase in the volume of purchases of electric cars, this connection will become stronger.

Table 3. Results of correlational analysis – 1. *(Source: calculated based on [4; 23; 24])*

Factor	Subsidy ratio to total price (%)	Total subsidy amount (USD)	One-time purchase subsidy amount (USD)
Subsidy ratio to total price (%)	1	-	-
Total subsidy amount (USD)	0.897149975	1	-
One-time purchase subsidy amount (USD)	0.915538086	0.965811788	1

Since we chose the Tesla company as an example, we analyzed the production of these electric cars in the USA and how much the state helps the Tesla company to develop. Based on the results of the research, a correlation analysis of the most significant indicators affecting the growth in demand for Tesla cars was carried out (Table 4).

Table 4. Results of correlational analysis – 2. *(Source: calculated based on [4; 23; 24])*

Factor	Tesla production (units)	Oil price		US GDP (USD billion)	Tesla R&D investment (USD billion)	Government incentives for Tesla (USD billion)
Tesla production (units)	1					
Oil price	0.808924403	1				
US GDP (USD billion)	0.975999766	0.7088722		1		
Tesla R&D investment (USD billion)	0.914347039	0.9665316		0.839253544	1	
Government incentives for Tesla (USD billion)	0.957468385	0.7080231		0.94779449	0.864321568	1

Based on the correlation analysis, the following conclusions can be drawn:

1. There is a strong positive correlation between the production of Tesla electric cars and the price of oil. This means that when the price of oil goes up, people are more likely to buy Tesla electric cars. This may be due to the fact that electric cars are a more environmentally friendly and cost-effective alternative to diesel and gasoline cars when oil prices are high.
2. There is a strong positive relationship between the production of Tesla electric cars and US GDP. This means that wealthier countries tend to produce more Tesla electric cars. This may be due to the fact that people in richer countries have more money to buy electric cars.
3. There is a strong positive relationship between Tesla's electric car production and R&D investment. This means that countries that invest more in electric car research and development tend to produce more Tesla. This may be due to the fact that greater investment in research and development leads to new technologies and more affordable Tesla electric cars.
4. There is a positive relationship between the production of Tesla electric cars and government incentives. This means that government subsidies and tax breaks for Tesla’s electric cars could stimulate their production. This may be due to the fact that government incentives make Tesla electric cars more affordable for consumers.
5. There is a positive relationship between the production of Tesla electric cars and the infrastructure of charging stations. This means that the development of the infrastructure of charging stations can make Tesla electric cars more convenient to use, which can lead to an increase in their demand and production (more charging stations make Tesla electric cars more practical for everyday use).

Table 5 illustrates the economic and social factors involved in the production of electric vehicles.

Table 5. Economic and social aspects of EVs development.

Economic factors	Social factors
Purchasing power of consumers. The level of welfare in the country where the manufacturer of electric vehicles operates affects the demand for their products. Strong economies with high-income levels tend to drive more demand for cars, including Tesla. On the other hand, during an economic downturn, consumers may be more inclined to purchase affordable alternatives rather than new cars;	Growing environmental awareness of the population, which leads to an increase in demand for ecological products, including Tesla electric cars. This is due to increasing concerns about climate change and air pollution;
Interest rates. The level of interest rates affects financing options for both the EVs manufacturer and its customers. Low interest rates can allow companies like Tesla to offer affordable financing plans, making the purchase of an electric car more attractive. Conversely, high interest rates can increase the cost of borrowing, making new cars less affordable for consumers;	Demographic factors, such as income distribution and the age of the population, which also affect demand for Tesla. Younger generations are more inclined to use electric vehicles, and people with higher incomes are willing to pay for Tesla's advanced features and technology;
Fuel prices. Changes in the price of gasoline and other fuels affect how attractive electric cars look compared to cars with traditional engines. With lower running costs, electric vehicles are becoming more attractive to consumers when fuel prices rise.	Concern for health, which leads to the growing popularity of ecological types of transport, such as Tesla electric cars. People who are concerned about the negative impact of air pollution on health, more often choose ecological alternatives.

The world is rapidly entering the era of electric cars, which has significant and multifaceted consequences. On the one hand, this opens new opportunities for the development of the economy, energy and ecology. The growth of the electric car market stimulates the creation of new jobs, gives impetus to the development of related industries, and contributes to reducing dependence on fossil fuels and improving the state of the environment.

DISCUSSION

The results of this correlation analysis suggest that there are several factors that may influence Tesla's production. These factors include the price of oil, US GDP, investment in research and development, government incentives. Based on the conducted analyses, it can be emphasized that the global transition to the production and use of electric vehicles is a critically necessary response to climate change, the reduction of fossil fuel reserves, and the growing need for sustainable development. This transition helps increase energy efficiency, reduce dependence on oil, and improve air quality in cities by reducing emissions of harmful substances.

CONCLUSIONS

Economic aspects of electric cars production include lower running costs for electric vehicles compared to fossil fuel vehicles, although the initial cost of electric vehicles is still high. However, with the growth of production scale, innovation and government incentives, the cost of electric cars tends to decrease, making them more affordable for a wide range of consumers. Electric vehicles also contribute to the creation of new jobs and the development of technologies in the field of batteries, electronics and software. Social aspects of electric cars production include improving the quality of life by reducing air and noise pollution in cities. The development of electric mobility also provides new opportunities for integration with modern concepts of urban transport, such as car sharing and intelligent transport systems, which contributes to more efficient use of vehicles and a reduction of the transport load on the infrastructure. Thus, despite the challenges associated with the need to reduce the cost of electric cars, develop the infrastructure of charging stations and ensure access to stable sources of green energy, the transition to electric cars has a significantly positive impact on both the economy and society as a whole. Promoting the production and adoption of electric vehicles is an important step towards a sustainable future.

ADDITIONAL INFORMATION

AUTHOR CONTRIBUTIONS

All authors have contributed equally.

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CONFLICT OF INTEREST

The Authors declare that there is no conflict of interest.

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РОЗВИТОК РИНКУ ЕЛЕКТРОМОБІЛІВ З АКЦЕНТОМ НА ЕКОЛОГІЧНІСТЬ

Упродовж останніх років світовий транспортний сектор активізувався в напрямі переходу на електромобілі, що працюють на відновлюваних джерелах енергії. Експерти прогнозують зростання ролі електромобілів у провідних економіках через виснаження викопного палива та наявності шкідливих викидів від двигунів внутрішнього згоряння. Зростання цін на енергоносії та жорсткі екологічні норми ще більшою мірою стимулюють цей перехід. Основною метою наукової роботи є вивчення взаємозв'язку між виробництвом електромобілів, державними субсидіями, цінами на нафту, ВВП на душу населення та інвестиціями в дослідження й розробки. Основним методом обрано кореляційний аналіз, але для візуалізації використано також графічний метод. Установлена значна позитивна кореляція між виробництвом електромобілів Tesla та ціною на нафту, яка вказує на те, що вищі ціни на нафту роблять електромобілі Tesla більш привабливою, економічно ефективною та екологічно чистою альтернативою бензиновим і дизельним автомобілям. На основі проведеного аналізу можна констатувати, що глобальний перехід до виробництва та використання електромобілів є критично необхідною відповіддю на зміну клімату, скорочення запасів викопного палива та зростання потреби сталого розвитку. Цей перехід допомагає підвищити енергоефективність, зменшити залежність від нафти й покращити якість повітря в містах за рахунок зменшення викидів шкідливих речовин.

Ключові слова: електромобілі, транспортування, стійкість, викиди CO_2, автомобільна промисловість

JEL Класифікація: C3, Q5, R4

Appendix 1. Data for regression analysis – 1. *(Source: [4; 23; 24])*

Country	Subsidy ratio to total price, %	Total subsidy amount, USD	One-time purchase subsidy, USD
South Korea	29	20,954	12,350
Denmark	39	19,554	18,700
Norway	47	16,203	15,200
China	25	15,324	13,260
USA	19	10,560	8,500
Spain	4	7,542	6,320
France	22	7,250	7,120
Netherlands	15	6,120	4,450
United Kingdom	16	5,430	4,730
Japan	11	4,740	3,860
Germany	14	4,520	3,800
Sweden	13	3,230	3,820
Switzerland	8	2,320	2,500
Portugal	3	1,300	410
Italy	1	120	120

Appendix 2. Data for regression analysis – 2. *(Source: [4; 23; 24])*

Costs	Nissan Leaf S	Skoda Octavia A8
Car cost, USD	30,500	25,550
Operating expenses, USD	1,200	10,000
Total expenses over 5 years, USD	31,700	35,550
Electricity/Fuel cost over next 5 years, USD (exchange rate USD = UAH 39.16 as of 10.04.2024)	151.5	7,277.83
Service maintenance (every 15,000 km) over 5 years, USD (exchange rate USD = UAH 39.16 as of 10.04.2024)	191.52	510.73
Internal combustion engine / Electric motor	1,200	2,000
Fuel supply and exhaust system	3,600	550
Gearbox	350	894
Battery	6,000	-
Annual mileage, thousand km	15	15
Operating period, years	5	5

Appendix 3. Data for regression analysis – 3. *(Source: [4; 23; 24])*

Year	Tesla production (units)	Oil price (USD)	US GDP (USD billion)	Tesla R&D investment (USD billion)	Government incentives for Tesla (USD billion)
2019	367,500	14.7	21,443.90	2.15	0.5
2020	509,700	21.41	20,892.90	3.5	1.00
2021	936,172	42.13	23,025.40	4.8	1.50
2022	2,056,360	102.82	25,300.70	5.6	2.00
2023	3,000,000	110.00	26,500.00	15.00	2.50

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