Proceedings of the 9th International Conference on Economic Management and Green Development
DOI: 10.54254/2754-1169/2025.22756

Evaluation of New Energy Vehicle Industry Competitiveness Based on the PSR Model

Qi Wang

School of Digital Economy and Management, Wuxi University, Wuxi, China
2113518726@qq.com

Abstract: Under the global energy transition and the "dual carbon" goal, the new energy vehicle (NEV) industry has become a core area for countries to seize strategic heights. Although China's NEV industry has ranked first in scale worldwide, it faces challenges such as regional competitiveness differentiation, structural imbalances in technological innovation, and urban-rural gaps in market promotion. Existing studies often focus on single technical or policy perspectives, lacking a systematic analytical framework. This research constructs an evaluation system with 17 indicators based on the Pressure-State-Response (PSR) model and uses the fixed-base range entropy method to analyze the spatio-temporal evolution of industrial competitiveness in 30 provinces (regions/municipalities) from 2011 to 2021. It reveals the synergistic mechanism between technological innovation and market response and the causes of regional imbalances. The findings are as follows: First, the average NEV competitiveness increased from 0.212 in 2011 to 4.176 in 2021, with an annual growth rate of 17.8%, but regional differentiation intensified. Second, technological innovation serves as the primary driving force, with a strong positive correlation between it and market response. Provinces like Jiangsu and Zhejiang achieved sustained competitiveness improvement through a closed loop of "technology R&D-policy subsidies-market promotion." Third, uneven policy resource allocation, infrastructure shortcomings, and differences in technology transfer efficiency are the main causes of regional imbalances. Based on this, corresponding strategies are proposed.

Keywords: New energy vehicles, Competitiveness evaluation, PSR model, Technological innovation, Regional imbalance

1. Introduction

Against the dual challenges of global climate change and energy security, the NEV industry, as a strategic fulcrum for achieving the "dual carbon" goals, has become a core area for countries to compete for industrial dominance. However, issues such as regional differentiation in industrial competitiveness, structural imbalances in technological innovation, and urban-rural gaps in market promotion restrict high-quality industrial development. Existing studies primarily focus on government-led technological innovation paths [1] and regional competitiveness evaluations [2], but the lack of a national-scale data system and theoretical framework limitations have resulted in insufficient systematic understanding of the mechanisms driving industrial competitiveness.

DOI: 10.54254/2754-1169/2025.22756

Scholarly research on NEV industries at home and abroad exhibits differentiated characteristics. Domestic studies emphasize macro-policy effects and technological innovation mechanisms. For example, Bai Mei pointed out that during the "13th Five-Year Plan" period, China's industrial competitive advantages were concentrated in market scale and policy-driven factors, and the "14th Five-Year Plan" period requires a shift toward deep technological innovation [3]. Jiang Wei and Huo Guoqing found significant differences in new energy module innovation capabilities between Beijing and Shenzhen through regional comparisons [4]. Foreign studies focus more on micro-driving factors for market promotion. Austmann confirmed the positive role of environmental awareness in electric vehicle development through consumer psychology analysis [5], while Jain revealed that government support reduces consumer perceived risk using the UTAUT model [6].

This study introduces the PSR (Pressure-State-Response) model proposed by Canadian statistician David to construct a national-scale evaluation system for NEV industrial competitiveness. Based on panel data from 30 provinces (regions/municipalities) across China from 2011 to 2021, this research constructs an evaluation system with 17 indicators to address the following key scientific questions: (1) The spatio-temporal evolution characteristics of China's NEV industrial competitiveness; (2) The synergistic mechanism between technological innovation and market response; (3) The internal causes of regional development imbalances. The research results will provide theoretical support for optimizing technological innovation layouts, promoting energy structure transformation, and improving market promotion systems, helping China transition from a "manufacturing powerhouse" to an "innovation powerhouse" in the NEV sector.

2. PSR model for new energy vehicle industry competitiveness

2.1. Definitions and relationships of elements

Pressure is the primary factor driving the development of the NEV industry. Pollutant emissions from traditional vehicles impose environmental pressures, while increasing electricity demand and continuous consumption of non-renewable energy generate carbon emissions, exacerbating environmental pollution. State refers to the competitive dynamic environment faced by the automotive industry ecosystem. Response represents the market vitality of the NEV industry, including infrastructure construction, market promotion, and utilization of NEVs, which improve the energy generation structure. The interaction mechanism under each element system is shown in Figure 1.

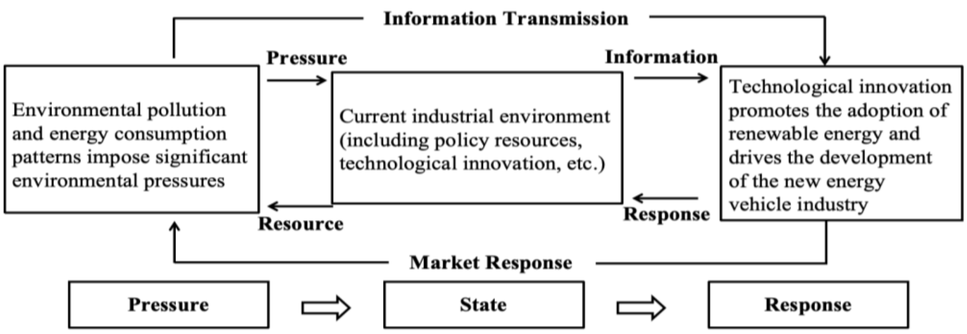

Figure 1: PSR model for the competitiveness of the new energy vehicle industry

2.2. Indicator selection for each element

Based on the mechanism of PSR model elements in the NEV industry, 17 evaluation indicators reflecting the characteristics of each PSR element are selected, considering the systematic features of

DOI: 10.54254/2754-1169/2025.22756

the NEV industry and internal/external environmental influences. The evaluation index system for NEV industry development competitiveness is constructed as shown in Table 1.

Table 1: Evaluation index system for the development competitiveness of the new energy vehicle industry [7]

Primary Elements	Secondary Elements	Tertiary Indicators	Indicator Direction
Pressure	Industrial Competition Pressure Environment	A1 Nitrogen Oxide Emissions of Motor Vehicles (ton)	-
		A2 Proportion of Thermal Power Generation (%)	-
		A3 Coal Consumption (10,000 tons)	-
		A4 Petroleum Consumption (10,000 tons)	+
		A5 Natural Gas Consumption (100 million cubic meters)	+
State	Industrial Competition Dynamic Environment	B1 Investment in Waste Gas Treatment (10,000 yuan)	+
		B2 Patents for Carbon Reduction Technologies in Fossil Energy (unit)	+
		B3 Patents for Energy-Saving and Energy Recovery Utilization Technologies (unit)	+
		B4 Clean Energy Technology Patents (unit)	+
		B5 Green Low-Carbon Technological Innovation Patents (unit)	+
		B6 Number of Patents for Carbon Emission Trading Technologies (unit)	+
		B7 Energy Storage Technology Patents (unit)	+
Response	Industrial Competition Vitality Environment	C1 Power Generation from Wind, Solar, and Nuclear Energy (100 million kWh)	+
		C2 Hydropower Generation (100 million kWh)	+
		C3 Sales Volume of New Energy Vehicles (unit)	+
		C4 Number of Public Electric Vehicles in Operation (unit)	+
		C5 Passenger Volume of Public Electric Vehicles (10,000 person-times)	+
		C6 Distribution of Charging Piles in Various Regions (unit)	+

3. Data sources and evaluation model

Due to incomplete data for Hong Kong, Macao, Taiwan, and Tibet, this study focuses on data from 30 provinces (regions/municipalities). Raw data are sourced from the National Bureau of Statistics online database, the China Society of Automotive Engineers, China Energy Statistical Yearbook, and China Environmental Statistical Yearbook, spanning 2011–2021. Missing data for individual years are imputed using interpolation [8].

4. Research results

4.1. Spatio-temporal evolution of NEV industry competitiveness

Using the fixed-base range entropy method on 2011–2021 panel data, the comprehensive competitiveness index of the NEV industry shows significant spatio-temporal differentiation (Table 2).

DOI: 10.54254/2754-1169/2025.22756

Table 2: Comprehensive competitiveness index of the new energy vehicle industry (2011, 2015, 2020, 2021)

Year	National average	Maximum value(Province)	Minimum value (Province)	Coefficient of regional variation
2011	0.212	Guangdong(0.717)	Ningxia(0.034)	0.89
2015	1.248	Guangdong(4.558)	Ningxia(0.065)	1.02
2020	3.267	Guangdong(15.619)	Ningxia(0.212)	1.18
2021	4.176	Guangdong(27.389)	Ningxia(0.353)	1.24

In the temporal dimension, nationally, the competitiveness index increased from 0.212 in 2011 to 4.176 in 2021, with an annual growth rate of 17.8%, though regional disparities widened. During 2011–2015, eastern provinces took the lead with an annual growth rate exceeding 25%.In 2016–2019, central-western provinces such as Anhui and Henan caught up via industrial transfer, and in 2020–2021, the Yangtze River Delta and Pearl River Delta regions maintained growth despite policy adjustments.

In the spatial dimension, the pattern of “strong east, weak west” is prominent. Among the top 10 provinces in terms of competitiveness in 2021, eastern provinces accounted for 70%, central provinces accounted for 20%, and only Shaanxi in the western region made the list, as shown in Table 3. The regional variation coefficient expanded from 0.89 in 2011 to 1.24 in 2021, indicating the intensification of the Matthew Effect.

Table 3: Competitiveness rankings of Top 10 provinces and key indicators in 2021

Province	Competitiveness Index	Technology Patents (units)	Charging Pile Density (units per 10,000 people)	Charging Pile Density (units per 10,000 people)
Guangdong	27.389	14,334	45.56	2.78
Jiangsu	16.996	19,389	25.42	3.82
Zhejiang	17.499	10,685	32.16	4.35
Shanghai	15.793	5,603	25.27	5.14
Shandong	11.830	6,575	19.54	1.74
Henan	12.593	2,902	24.55	0.84
Anhui	6.014	4,702	7.85	1.05
Fujian	5.443	2,506	8.25	0.73
Beijing	11.571	7,574	13.21	3.38
Shanxi	4.345	3,747	6.51	0.79

4.2. Synergistic mechanism between technological innovation and market response

In terms of technological innovation, Guangdong Province held 14,334 technical patents in 2021, with both clean energy and energy storage technology patents ranking first nationally, driving its response element score to stay top in China for five consecutive years. Regarding market response, a strong positive correlation exists between charging pile density and new energy vehicle sales—Zhejiang’s charging pile number in 2021 grew 113-fold from 2011, directly boosting its sales to rank second nationwide. Concerning synergistic effects, provinces like Jiangsu and Zhejiang achieved sustained competitiveness enhancement via the "technological R&D—policy

DOI: 10.54254/2754-1169/2025.22756

subsidies—market promotion" closed loop. For instance, Jiangsu's technical patents and new energy vehicle sales in 2021 accounted for 12.5% and 9.3% of the national total respectively, with a synergy index reaching 0.91.

4.3. Internal causes of regional imbalances

First, there are disparities in policies and resource endowments: eastern provinces such as Guangdong and Shanghai have R&D investment intensity exceeding 2.5%, with government subsidies accounting for over 30% of industrial investment; in contrast, western provinces like Gansu and Qinghai have R&D investment of less than 1%, with weaker policy support. Second, the western region faces infrastructure shortcomings, in 2021, charging pile density in western provinces was less than 8% of the eastern average, and public transport electrification rates were only one-third of those in the east, constraining market penetration. Third, central-western provinces lag in technology transfer efficiency, their technology patent conversion rates are significantly lower than those in the east.

5. Conclusion

The evaluation of China's new energy vehicle (NEV) industry competitiveness from 2011 to 2021 based on the PSR model reveals that while the overall industrial competitiveness has grown rapidly, regional differentiation remains pronounced. Eastern provinces continue to lead through the synergistic effects of technological innovation and market response, while only Anhui, Henan, and Shaanxi from central-western regions ranked among the top 10. The study finds that technological innovation and market response are closely linked and are the main reasons for competitiveness, while uneven distribution of policy resources, poor infrastructure, and gaps in technology transfer efficiency are key reasons for differences between regions. Thus, it's important to implement differentiated policies to focus on technological upgrading and industrial cluster development in the east. Establish cross-regional industry-university-research platforms to enhance technology conversion rates; Improve charging network layouts, and explore mechanisms for carbon emission trading and inter-provincial technology transfer. These measures aim to achieve balanced industrial development through a "technological innovation-policy guidance-market-driven" triple-engine approach, contributing to the realization of "dual carbon" goals.

References

[1] *Dong F, Liu Y. Policy evolution and effect evaluation of new-energy vehicle industry in China[J]. Resources Policy, 2020, 67: 101655.*

[2] *Xie W H, Zeng D C. Empirical study on the competitiveness evaluation of Guangdong's new energy vehicle industry based on the new diamond model[J]. Science and Technology Management Research, 2019, 39(9): 56-61.*

[3] *Bai M. Research on the global competition pattern of the new energy vehicle industry[J]. Price Theory and Practice, 2020(1): 25-31.*

[4] *Jiang W, Huo G Q. Research on regional electric vehicle industry competitiveness based on industrial chain transformation: A case study of Beijing and Shenzhen[J]. Management Modernization, 2016, 36(4): 48-51.*

[5] *Austmann L M. Drivers of the electric vehicle market: A systematic literature review of empirical studies[J]. Finance Research Letters, 2021, 41: 101846.*

[6] *Jain N K, Bhaskar K, Jain S. What drives adoption intention of electric vehicles in India? An integrated UTAUT model with environmental concerns, perceived risk and government support[J]. Research in Transportation Business & Management, 2022, 42: 100730.*

[7] *Rapport D, Friend A. Towards a comprehensive framework for environmental statistics:Astress—response approach[M]. Ottawa:Statistics Canada, 1979.*

[8] *National Bureau of Statistics of China. (2023). China Statistical Yearbook Database. https://www.stats.gov.cn/sj/*