

Research on Influencing Factors of Green Innovation of New Energy Vehicles Based on Bayesian Networks

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Abstract. This article analyzes the four quasi-measurement levels including industrial development, and collects various data such as government policies, fiscal data, and company patents. This paper analyzes the implementation process of policies, explores the research factors of enterprise innovation ability, and obtains 11 indicators. Based on the Bayesian network constructed with 11 indicators, we use linear regression methods to explore the influencing factors of the green innovation capability of new energy automobile companies, and quantify the degree of influence of each factor. Based on the quantitative results, this paper provides suggestions for government industrial strategic planning, taxation policies, government procurement, etc., and provides a reference for the development of new energy automobile enterprises' industry and technology.

1 Introduction

Nowadays, facing the severe situation of tightening resource constraints, serious environmental pollution, and degradation of the ecosystem, people have gradually begun to establish the concept of ecological civilization that respects nature, conforms to nature, and protects nature, and follows the path of sustainable development. Under the pressure of energy and environmental protection, new energy vehicles will undoubtedly become the development direction of future automobiles. If new energy vehicles develop rapidly, based on the 140 million Chinese car ownership in 2020, 32.29 million tons of oil can be saved, 31.1 million tons of oil can be replaced, and a total of 63.39 million tons of oil can be saved and replaced, which is equivalent to reducing the demand for automobile oil by 22.7 %. Before 2020, saving and replacing petroleum will be realized by the development of advanced diesel vehicles and hybrid vehicles. By 2030, the development of new energy vehicles will save 73.06 million tons of oil, replace 91 million tons of oil, and save and replace a total of 164.06 million tons of oil, which is equivalent to reducing automobile oil demand by 41%. By then, biofuels and fuel cells will play an important role in the substitution of automobile petroleum. Since 2008, the Chinese government has launched the "Ten Cities and Thousand Vehicles" energy-saving and new energy vehicle demonstration project, and now requires the in-depth implementation of the national strategy for the development of new energy vehicles, promotes the high-quality and sustainable development of China's new energy vehicle industry, and accelerates the establishment of a powerful automobile nation. The automotive market

has grown rapidly from immature to today. The government plays a pivotal role in this process. This paper is based on refining the indicators of the green innovation influencing factors of new energy vehicles based on the formulation, implementation and effects of public policies. By constructing a Bayesian network model, this paper explores the impact of various factors on the green innovation of new energy vehicle companies. Through data collection, model training, empirical testing, and predictive analysis, we can quantify the influencing factors of green innovation of new energy vehicles, analyze the reasons behind them, and put forward conclusions and suggestions based on the current technological development and policy background.

2 Literature review

Since the issue of energy scarcity and new energy vehicle technology has attracted people's attention, many people have studied the technology of new energy vehicle technology. Xu Le et al. used fixed-effects model, double difference method and other methods to test the new energy technology innovation effect of key industrial policies and their mechanism from the demand side, and concluded that different levels of policies have different effects on different regions. [1] Zang Chongchong analyzed the relationship between government subsidies, corporate R&D investment, and green technology innovation performance, and analyzed the relationship between government and green innovation from the perspective of direct subsidies and tax incentives. [2] Peng Siyu collects and sorts out the new energy vehicle policy data issued at the national level, and uses content analysis to analyze the policy text. From the three stages of

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initiation, promotion, and development, it is divided into three categories: supply type, demand type and environmental type. A comparative analysis of the automobile industry policies of the two countries. [3] From the perspective of industry pollution heterogeneity, Zhu Dongbo theoretically analyzes the mechanism of environmental regulation and technological innovation on the green transformation of industrial structure, constructs a dynamic panel model, uses provincial panel data and systematic GMM methods, etc., to strengthen regional environmental regulations Policy recommendations are made in terms of policy regulation and speeding up the process of technological green innovation. [4] Dong Zhiqing and others selected panel data from 154 prefecture-level cities in China, used principal component analysis to evaluate the economic freedom of each city, and explored the relationship between economic freedom and green technological innovation and its causes. Corresponding policy recommendations were put forward from the urban green technological innovation and its constraints. [5] Based on the input-output data of industrial enterprises, Tian Hongbin and others used the GML index to measure the efficiency of green innovation and its decomposition, and analyzed the impact of FDI inflows on the efficiency of green innovation in the three cases of command control, investment and cost environmental regulations. influences. It is concluded that the combination of appropriate environmental regulations and scientific FDI introduction policies can effectively improve the efficiency of green innovation. [6] Zhang Shuai took the supply chain collaboration of corporate green innovation as the research object, and discussed the supply chain collaboration mechanism of corporate green

innovation. The coordination mechanism is designed by game theory method. [7]

In the past research, few people used Bayesian theory and other statistical methods to conduct research, and they did not explore some of the factors. Based on Bayesian network theory, this paper can better analyze the relationship between factors, and use statistical methods to quantify the relationship between low analysis policies and other factors and green innovation of new energy vehicles.

3 Data and Methodology

3.1 Index system construction

The rapid development of new energy vehicles has largely benefited from government policy encouragement and promotion. In addition, the overall industry standards of the relevant technical level also determine the bottleneck of the development of this new energy vehicle technology. Whether a technology can be recognized by consumers is also related to the publicity of the technology by social media organizations. Based on the actual development of new energy vehicle technology, the number of patents of new energy vehicle companies is used as a standard to measure the innovation ability of the company, and four aspects are selected as the criterion layer: industrial development, technology research and development, application promotion, and environmental protection. Based on the four quasi-measurement layers, a total of 11 indicators are selected as the indicator layers. The specific evaluation system is shown in Table 1.

Table 1. Green Innovation Evaluation System for New Energy Automobile Enterprises

Target layer	Criterion layer	Index layer	Data Sources
Enterprise Innovation	Industrial Development	Financial Subsidy	Government agency
		Tax Incentives	Government agency
		Strategic Planning	Government agency
		Intellectual Property	Government agency
	Technology R & D	Battery Technology	Related companies and manufacturers
		Charging Technology	Related companies and manufacturers
	Application promotion	Government Procurement	Government agency
		Propaganda Power	Social media agency
		Infrastructure	Government agency
	Environmental protection	Access Rules	Government agency
		Environmental Regulation	Government agency

3.2 Data processing and methods

The theoretical basis of Bayesian networks is derived from Bayes' theorem.

$$P(H_i|E) = \frac{P(E|H_i)P(H_i)}{\sum_{k=1}^n P(E|H_k)P(H_k)}$$

Since the static Bayesian theory cannot dig out the direct correlation between factors, a Bayesian network is

constructed and the direct relationship of various indicators is connected, making the model more practical. In this paper, when the structure of the Bayesian network is known but the parameters are unknown, we must use the observed data to estimate the online parameters, so we need to use the maximum likelihood estimation method to supplement the network data.

Given a probability distribution D, assuming its probability density function or probability aggregation

function is f_D , and a distribution parameter θ , we can extract a sample X_1, X_2, \dots, X_n with n values from this distribution, and pass Using f_D , we can calculate its probability. However, we may not know the value of θ , so we can extract a sample X_1, X_2, \dots, X_n with n values from this distribution, and then use these sampled data to estimate θ .

This article will take the number of patents as a measure of the innovation capability of a company. By analyzing the relationship between various indicators, the Bayesian network structure as shown in Figure 1 is

constructed. After constructing the model, collect various indicator data of mainstream new energy automobile companies from the data source on a monthly basis since 2014. After data processing such as data cleaning and data filling, it is standardized, and then the value of each indicator is graded, divided into high (H) and low (L) levels, and substituted into the Bayesian network for maximum likelihood estimation Fitting training, get the probability of each node, and then provide the basis for the next step of predictive analysis.

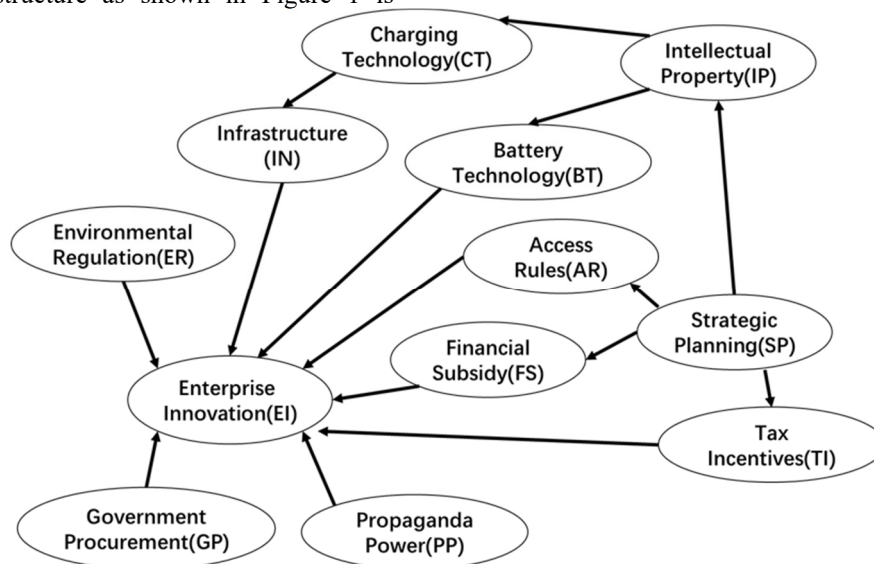


Figure 1. Bayesian network structure of green innovation for new energy vehicles

4 Empirical Analysis

After collecting and cleaning the patent data of each category of the top five new energy vehicle companies. After bringing these data into the Bayesian network, the

probability assignment of each node of the Bayesian network is completed. This article considers the different permutations and combinations of various factors, and obtains the innovation incentive effect through traversal. The ranking of the probability values of the innovation nodes is shown in the table 2.

Table 2. Sorting of probability values of EI nodes

FS	TI	SP	IP	BT	CT	GP	PP	IN	AR	ER	P(EI=H)
L	L	H	H	L	H	H	L	L	H	L	0.647059
L	L	H	H	L	L	H	L	L	H	L	0.647059
L	L	L	H	L	H	H	L	L	H	L	0.647059
L	L	H	L	L	H	H	L	L	H	L	0.647059
L	H	L	H	H	L	H	H	H	L	H	0.622642
L	H	L	H	H	H	H	H	H	L	H	0.622642
L	H	H	H	H	L	H	H	H	L	H	0.622642
H	L	H	H	L	H	L	L	L	H	L	0.583333
H	L	L	H	L	H	L	L	L	H	L	0.583333
H	L	L	H	L	L	L	L	L	H	L	0.583333

Strategic Planning and Government Procurement has a great influence on the probability of EI nodes. In order to further study the relationship between them, this paper uses the method of linear regression to obtain the coefficients of each factor in the linear model, and use the coefficients to determine the impact on the EI node, as shown in Table 3.

Table 3. The coefficients of each factor in the model

	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
(Constant)	0.568	0.016		34.514	0.000
FS	-0.029	0.008	-0.255	-3.725	0.000
TI	0.124	0.016	0.980	7.870	0.000
SP	-0.009	0.008	-0.075	-1.095	0.279
IP	-0.009	0.008	-0.075	-1.095	0.279
BT	-0.030	0.011	-0.276	-2.811	0.007
CT	-0.008	0.007	-0.075	-1.184	0.242
GP	0.030	0.011	0.242	2.813	0.007
PP	-0.022	0.012	-0.200	-1.846	0.070
IN	-0.018	0.010	-0.163	-1.798	0.078
AR	0.039	0.011	0.363	3.446	0.001
ER	-0.039	0.011	-0.363	-3.594	0.001

The largest coefficient is TI. It can be seen that Tax Incentives has a greater impact on the green innovation of new energy vehicle companies. In addition, Government Procurement and Access Rules also have a certain impact on corporate innovation.

5 Conclusion

Based on the results of the previous analysis, combined with the current development of the new energy automobile industry, we draw conclusions and recommendations as follows:

(1) The government's strategic planning for the new energy vehicle industry plays a decisive role in the development of new energy vehicle technology to a certain extent. Therefore, the government should accurately position the industrial plan and formulate a reasonable industrial plan based on the actual situation.

(2) Government procurement can stimulate new energy vehicle companies to actively bid, and the development of procurement specifications can stimulate the technological development of new energy vehicle companies. Under the current situation that electric public transportation has become widespread, the public transportation should be updated in time to promote new energy and the development of automotive technology.

(3) Compared with direct subsidies, tax incentives have a greater positive effect on the technological innovation of new energy companies. The government should further formulate detailed and reasonable preferential policies in accordance with the actual development of the industry in terms of tax policies.

(4) By improving the detail of the access rules, the company's green innovation capabilities can be further strengthened.

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