



Research on Quantitative Evaluation of New Energy Vehicle Policy in Hebei Province

Tianzun Wang¹, Yongguo Chen^{1,*}, Shuai Hong², Huina Li¹

¹Institute of Economic Research, Hebei University of Economics and Business, Shijiazhuang 050061, China

²Hebei Coordinated Innovation Center for BTH Coordinated Development, Hebei University of Economics and Business, Shijiazhuang 050061, China

*Corresponding author: email:
15933601367@163.com

Abstract. The Chinese government has made the new energy vehicle industry a new pillar for building a modern industrial system during the 14th Five-Year Plan period. On the basis of previous research results, a quantitative evaluation model of new energy vehicle policy in Hebei Province is constructed with PMC index and PMC surface through text mining. The research results show that the overall design of the new energy vehicle policy in Hebei Province is relatively reasonable, of which 75% of the policies are excellent, and 25% of the policies are acceptable. Furthermore, it is found that there is a lack of regulatory and diagnostic policies in policy types, no long-term policy guidance in policy timeliness, unbalanced use of policy tools, and insufficient coverage of policy objectives.

Keywords: New Energy Vehicle Policy; PMC Index Model; Policy Evaluation; Hebei Province

1 Introduction

Since the 21st century, China has formulated a series of policies to promote the development of new energy vehicles. From the Notice on Carrying out the Pilot Work of Demonstration and Promotion of Energy-Saving and New Energy Vehicles ^[1] in 2009 to the latest of New Energy Vehicle Industry Development Plan ^[2] (2021-2035) issued in 2020, it shows that the New Energy Vehicle has been more and more attention. Encouraged by policies and driven by the market, new energy vehicles in China will increase from 18,000 in 2013 to 3.521 million in 2021. With the expansion of the global market of new energy vehicles and the gradual realization of dual carbon goal ^[3], new energy vehicles will enter a stage of rapid development. From the perspective of theoretical logic and practical experience, promoting the high-quality development of new energy vehicles is important and relevant policies are needed for guidance and support ^[4].

In order to find the motivation to further improve the overall industrial chain level, eliminate the level difference between provinces, and promote the smooth operation of

new energy market in China, it is necessary to construct the PMC index model of new energy vehicle policy in Hebei Province. Deeply excavation the advantages and disadvantages of the new energy vehicle policy in a quantitative and qualitative way became the main contents^[5]. It is the scientific decision-making basis of accelerating the construction of new energy vehicle market in Hebei Province for putting forward corresponding optimization paths and suggestions.

2 Data sources and Model settings

2.1 Data sources

Since the Chinese government launched the electric vehicle major science and technology project in 2001^[6], the policies during this period were basically focused on the national science and technology plan, and the policies were single and lacked continuity. It was not until 2010 that relevant policies were introduced one after another. Therefore, the time span of sample source selection is the relevant new energy vehicle policies issued by Hebei Province after 2010. In order to ensure the comprehensiveness and objectivity of the content coverage of the policy samples, the policy query is carried out by the legal professional database of Peking University Magic Weapon^[7], and the website of the Hebei Provincial Government is logged in again for retrieval and supplementation to ensure the accuracy of the sample. Finally, the policies to be evaluated for new energy vehicles in Hebei Province within this time period are retrieved, as shown in Table 1.

Table 1. Policy Text of New Energy Vehicles in Hebei Province

Number	Code	Policy Name	Publishing department	Date Issued
1	<i>P1</i>	Energy Saving and New Energy Automobile Industry Development Plan	The People's Government of Hebei Province	27 December 2012
2	<i>P2</i>	Measures for Accelerating the Development, Popularization and Application of New Energy Automobile Industry in Hebei Province	The People's Government of Hebei Province	26 December 2015
3	<i>P3</i>	The 13th Five-Year Development Plan of New Energy Automobile Industry in Hebei Province (2016-2020)	Industry and Information Technology Department of Hebei Province	30 December 2015
4	<i>P4</i>	Measures for Accelerating the Development, Popularization and Application of New Energy Automobile Industry in Shijiazhuang City	Shijiazhuang Municipal People's Government	28 March 2016
5	<i>P5</i>	Implementation Opinions on Accelerating the Development, Popularization and Application of New Energy Vehicles	Xingtai Municipal People's Government	19 January 2015
6	<i>P6</i>	Implementation Opinions on Accelerating Industrialization of Power Battery and Energy Storage Battery,	Handan Municipal People's Government	08 August 2013

		Cultivating and Developing New Energy Automobile Industry Work Plan for Developing Public Transport and Promoting New Energy Vehicles	Langfang Municipal People's Government	13 October 2013
7	P7	Implementation Plan of New Energy Vehicle Charging Infrastructure Construction in Chengde County	People's Government of Chengde County	14 June 2019

2.2 Model settings

2.2.1. Variable classification and parameter identification.

The 8 new energy vehicle policy texts in Hebei Province were imported into the text mining database, and the relevant policy texts were subjected to word segmentation and frequency preprocessing with the help of the text mining software ROSTCM.6, and representative words were extracted from them. Considering that the content of the policy is new energy vehicles, high-frequency words such as new energy vehicles and policy that have no practical significance, and some degree adverbs and verbs that have no obvious effect on the results, such as major, improve and so on are excluded. After removing the above words, 60 high-frequency effective words are finally formed, which provides an important reference for the setting of secondary variables.

Following the modeling principles of PMC index model, on the basis of text mining, combined with the actual situation of the current development of new energy vehicles and the relevant research of two scholars Kuang^[8] and Yang^[9], the PMC policy for new energy vehicles in Hebei Province was finally constructed. For the setting of relevant parameters of the PMC index model, the binary method is mainly used. It is assumed that each secondary variable has the same importance to the input and output, so as to effectively take into account each variable. When the relevant expression in the policy is evaluated to meet the evaluation criteria in the corresponding secondary variable, the secondary variable is assigned a value of 1. Otherwise, it is 0.

2.2.2. Calculation of PMC Index.

The calculation of the PMC index model mainly includes four aspects^[10]. First, put the above primary and secondary variables into the multi-input-output table. Secondly, combine Formula (1) and Formula (2) to assign certain values to the secondary variables in the multi-input-output table. The value of the variable obeys the [0,1] distribution. Thirdly, the value of the first-level variable is calculated according to Formula (3). Lastly, the first-level variable in the previous step is added up by Formula (4). Finally, the PMC index of new energy vehicle policy in Hebei Province is obtained. The detailed calculation formula is as follows.

$$X \sim N[0,1] \tag{1}$$

$$X = \{XR: [0 \sim 1]\} \tag{2}$$

$$X_t \left(\sum_{j=1}^n \frac{x_{tj}}{r(x_{tj})} \right), t = 1,2,3,4,5,6,7,8,9,10, \dots, \infty \tag{3}$$

Where t is a primary variable and j is a secondary variable.

$$PMC = \left\{ \begin{array}{l} X_1 \left(\sum_{i=1}^6 \frac{X_{1i}}{6} \right) + X_2 \left(\sum_{j=1}^3 \frac{X_{2j}}{3} \right) + X_3 \left(\sum_{k=1}^3 \frac{X_{3k}}{3} \right) + \\ X_4 \left(\sum_{l=1}^5 \frac{X_{4l}}{5} \right) + X_5 \left(\sum_{m=1}^{10} \frac{X_{5m}}{10} \right) + X_6 \left(\sum_{n=1}^4 \frac{X_{6n}}{4} \right) + \\ X_7 \left(\sum_{o=1}^3 \frac{X_{7o}}{3} \right) + X_8 \left(\sum_{p=1}^4 \frac{X_{8p}}{4} \right) + X_9 \left(\sum_{r=1}^2 \frac{X_{9r}}{2} \right) + X_{10} \end{array} \right\} \quad (4)$$

Through the above calculation formula, the input-output table of the new energy vehicle policy in Hebei Province is finally obtained. According to the Ruize criteria for grading policies, 9-10 (Perfect), 7-8.99 (Excellent), 5-6.99 (Acceptable), 0-4.99 (Low). And finally the PMC index of new energy vehicle policy in Hebei and evaluation grades are determined (Table 2).

Table 2. PMC index of new energy vehicle policy in Hebei Province

Primary variables	$P1$	$P2$	$P3$	$P4$	$P5$	$P6$	$P7$	$P8$	Average
$X1$	0.83	0.67	0.83	0.67	0.67	0.83	0.5	0.83	0.73
$X2$	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
$X3$	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
$X4$	1	0.8	0.8	0.8	1	0.6	0.2	0.6	0.73
$X5$	0.8	0.8	1	0.7	0.7	0.7	0.3	0.3	0.66
$X6$	0.75	1	1	1	1	0.75	1	1	0.94
$X7$	1	1	1	1	1	1	0.33	0.67	0.88
$X8$	1	1	1	1	1	1	1	1	1
$X9$	1	1	1	1	1	0.5	0.5	0.5	0.81
$X10$	1	1	1	1	1	1	1	1	1
PMC-Index	8.04	7.93	8.29	7.83	8.03	7.04	5.49	6.56	7.4
Rank	2	4	1	5	3	6	8	7	—
Level	E	E	E	E	E	E	A	A	—

Note: E stands for Excellent, A stands for Acceptable.

2.2.3. PMC Surface Map Construction.

The surface chart can display the quantitative results more intuitively, and clearly see the differences between various policies. The degree of fluctuation of the surface map can be used to determine the gaps in the policy. The smaller the degree of fluctuation, the more reasonable the internal structure of the policy and the more detailed the policy [11].

The premise of constructing the PMC surface graph is to calculate the corresponding matrix [12]. The PMC matrix is a 3×3 matrix composed of 9 first-level variables. Since there are 10 first-level variables, and the first-level variable X10 does not have any second-level variables, the score of each policy is 1. Under the premise of considering the matrix symmetry, the first-level variable X10 is eliminated, and finally a 9 first-level variable is constructed. The third-order square matrix formed by the variables

can more intuitively show the internal consistency and rationality of the policy. The calculation formula of the PMC surface is shown in Formula (5).

$$\text{PMC-Surface} = \begin{pmatrix} X1 & X2 & X3 \\ X4 & X5 & X6 \\ X7 & X8 & X9 \end{pmatrix} \tag{5}$$

Finally, the PMC surface map of new energy vehicle policy in Hebei is constructed. Due to space limitations, only the PMC surface maps of the two policies, P3 with the highest PMC index score and P7 with the lowest score, are listed (Figure 1 and Figure 2). By comparing the P3 and P7 policies, the degree of depression and advantages and disadvantages of different policies can be seen more intuitively.

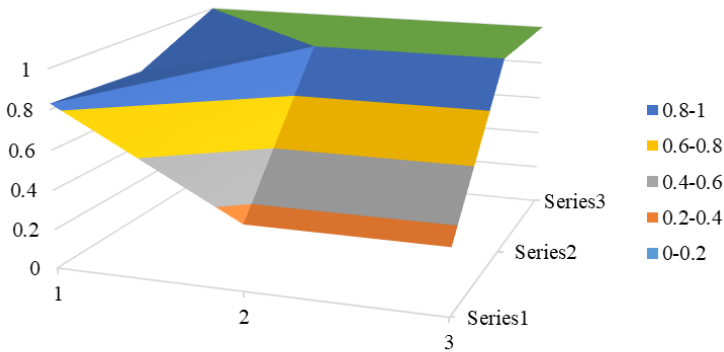


Fig. 1. PMC-Surface of P3

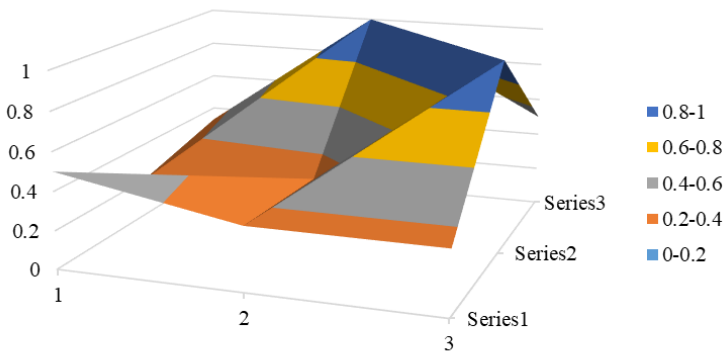


Fig. 2. PMC-Surface of P7

3 Results Analysis

There are the 8 new energy vehicle policies in Hebei Province, and the average PMC index is 7.4. 75% of the policy evaluation grades are Excellent (3 Provincial policies and 3 Municipal policies), and 25% policy evaluation grades are Acceptable (1 Municipal policy and 1 County policy). There are no Perfect policies and Low policies. The specific ranking is as follows $P3 > P1 > P5 > P2 > P4 > P6 > P8 > P7$. Overall, the new energy vehicle policy in Hebei Province is scientific and reasonable. The Provincial, Municipal and County governments have a strong sense of coordination when formulating policies, which has effectively promoted the construction and promotion of the local new energy vehicle market so as to promote the healthy development of related industries and economy. It is worth noting that the lack of a Perfect policy to a certain extent indicates that the quality of new energy vehicle policy in Hebei Province still has a certain room for improvement.

The average value of the 9 first-level variables in the 8 policies is made into a radar chart, which can more intuitively and clearly show the shortcomings of the new energy vehicle policy in Hebei Province. It is also an aspect that needs to be paid attention to in the process of formulating new energy vehicle policies in Hebei Province in the future (Figure 3).

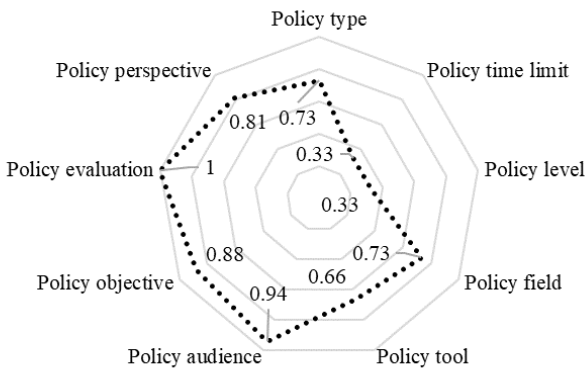


Fig. 3. Hebei Province's New Energy Vehicle Policy Radar Map

The mean value of Policy type X1 is 0.73. It means that the new energy vehicle policy in Hebei Province has a strong role in forecasting, suggesting, describing and guiding. The average value of the Policy time limit X2 is 0.33. It means that Hebei Province has not effectively connected the long, medium and short periods in the process of formulating the new energy vehicle policy. It emphasis on the development of policies in some period too much, ignoring the long-term implementation of policies. The average value of Policy level X3 is 0.33. It means that the selection of policies is mainly related to Hebei Province, and the sample selection range is small. The issuing units of relevant policies are mainly issued by individual departments, and there is a lack of joint issuing

agencies. The average value of X4 in the Policy field is 0.73. It means that the new energy vehicle policy of Hebei Province covers a wide range of fields and involves a deep level. The average value of Policy tool X5 is 0.66. It means that Hebei Province has used a variety of policy tools in formulating new energy vehicle policies to promote the construction and development of the local new energy vehicle market. The average value of the Policy audience X6 is 0.94. It means that the new energy vehicle policy of Hebei Province currently involves a wide range of audiences. The mean value of Policy target X7 is 0.88. It means that Hebei Province has a clear policy target for new energy vehicles. The mean value of Policy evaluation X8 is 1. It means that the new energy vehicle policy plan in Hebei Province is scientific and reasonable. The average value of the Policy perspective X9 is 0.81. It means that the new energy vehicle policy Hebei Province has a clear grasp of the perspective, and both macro and micro levels are involved.

4 Conclusions

Based on the PMC index model, a quantitative evaluation of 8 new energy vehicle policies in Hebei Province after 2010 was conducted through text mining, and the following main research conclusions were obtained.

First, the overall design of the new energy vehicle policy in Hebei Province is more reasonable. Among the 8 selected policy texts, the average PMC index is 7.4. 75% of the policies (P1-P6) are rated as Excellent. Provincial policies and prefectural policies account for 50% respectively. 25% of policies (P7, P8) is rated as Acceptable with one Prefecture-level policy and one County-level policy. It means that Hebei Province fully considers the local market conditions and the future development trend of the industry. The government of Hebei Province formulates new energy vehicle policies, with national strategic documents and laws and regulations.

Second, there is still a lot of room for improvement of new energy vehicle policy in Hebei Province. From the new energy vehicle policy input table 2, it can be found that the Policy type X1 is mainly based on advice, description, guidance and prediction. There is a lack of regulatory and diagnostic policies. Only the P5 policy involves supervision, and most City and County-level policies do not cover diagnosis (P4, P5, P7, P8). The Policy limitation X2 is mainly short-term and medium-term policies, lacks long-term policy guidance, and fails to effectively combine long-term planning and short-term goals. The use of Policy tools X5 is structural unbalanced, more policy tools such as financial support, political strategies and public utilities are used. But there is a serious lack of policy tools such as international cooperation, talent development and legal protection. Policy objective X7 is mostly based on promotion and application, although the overall score of this indicator is Good, but the policy target of basic research and development has less coverage. It is not conducive to promote the sustainable development of the new energy vehicle industry in Hebei Province.

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