Analysis on Formative Factors of New energy Industries Agglomeration at the Background of Digitalization-Evidence from Yangtze River Delta

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Abstract: Based on the formative factors of the formation of new energy industry cluster in the Yangtze River Delta, this paper uses the location quotient and industrial agglomeration index to make a comprehensive regression analysis on the panel data of the Yangtze River Delta from 2010 to 2019, and concludes that local energy dependence, economic development level, scientific research investment and output level are the main driving factors for the formation of new energy industry cluster in the Yangtze River Delta. Therefore, we should promote the formation of new energy industry cluster by improving the level of public service facilitation, relying on digital policy development, improving the technological innovation system, accurately positioning energy dependence and demands, as well as increasing the proportion of return on investment.

1. Introduction
The long-term consumption of traditional energy has brought ecological environment crisis and pollution disaster. Entering the 21st century, China's economy has been developing at a high speed. The synchronous growth of traditional energy demands and utilization makes the ecological environment problems in some regions increasingly prominent, so the demand for the development of new energy industry is growing. “The fourth industrial revolution" breaks the traditional manufacturing. COVID-19 epidemic pressure, remote control and mass customization technologies accelerate the transformation of industries." The outline of the Yangtze River Delta regional integration development plan” puts forward the strategic positioning of regional high-quality development model for the Yangtze River Delta region, which focuses on taking new energy as a key industry and building a national and world-class emerging industrial cluster. At present, the new energy industry in the Yangtze River Delta is developing rapidly, with outstanding performance in wind energy, solar energy, biomass energy and other fields. However, in the era of intelligent manufacturing, there are still some factors restricting the development of the industry, such as R&D and promotion difficulties, digital development bottlenecks and so on. Since the implementation of the national strategy for the development of regional integration in the Yangtze River Delta, it has set an example in promoting the production of new energy industry to replace the traditional energy industry and improving the ecological environment. It is a strong capacity advantage. However, compared with the real world-class industrial clusters, the world influence of enterprise leaders is still very limited, and the source power of key core technologies is lacking. When studying the new energy industry in the Yangtze River Delta, this paper takes the development indicators of wind power generation and photovoltaic power generation industry as the alternative measure of the new energy industry, analyzes the key influencing factors, and puts forward the corresponding
2. Researches on the elements of new energy industry cluster

Some scholars define the new energy industry cluster as an ecological friendly strategic new enterprise cluster. Guo Liwei [1] (2012) defined the new energy industry cluster as the concentration, connection and cooperation of relevant new energy industry enterprises and institutions in a specific geographical location.

Jozsef Benedek (2013) described the new energy industry cluster as an ecological enterprise cluster, which mostly adheres to the concept of sustainable development. Fei Li [2] et al. (2015) regarded the new energy industry as an industrial development link connecting sustainable development and economic effect; Liang Huichao (2017) concluded that the new energy industry cluster is actually a strategic emerging industry cluster based on the concept that the new energy industry is included in the scope of strategic emerging industries. On the whole, the existing literature on new energy industry is rich in content, but lack of relevant cluster effect research, especially for the analysis of regional industrial clusters with regional advantages. The main empirical method used in the study is to establish the relevant regression model.

Wheeler, C.H. [4] (2009) used panel regression model to study the relationship between high-tech industrial agglomeration and productivity, and concluded that the industrial scale in metropolitan areas is positively correlated with the frequency of computer use of workers. Qiu Licheng (2012) analyzed the EU's new energy industry agglomeration by establishing a panel model, and concluded that the long-term and short-term industrial policies, energy dependence and energy prices all significantly affect the new energy industry agglomeration. Nambuge, D (2015) and others measured the performance of industrial clusters in their countries by regions, and evaluated the competitiveness of regions in attracting and retaining industrial clusters. Zhang Lang et al. (2021) established three panel models of spatial error, lag and Dubin model, and concluded that cluster development can not only promote local economic growth, but also produce significant positive economic spatial spillover effect. Based on the analysis of indicators and the empirical analysis of panel regression model, this paper studies the composition elements of new energy industry cluster in the Yangtze River Delta under the digital background.

3. The current situation of new energy industry cluster in Yangtze River Delta

Referring to the practice of Liang Huichao et al. [3] (2017), this paper uses four indicators: location quotient (LQ), Herfindahl coefficient (H), spatial Gini coefficient (G) and spatial agglomeration index (EG) to investigate the new energy industry agglomeration in the Yangtze River Delta region.

3.1 Data explanation of new energy industry cluster analysis in Yangtze River Delta

According to the annual report of China's new energy industry from 2018 to 2019, wind power generation and photovoltaic power generation are still the main components of the new energy industry. In this paper, the development of wind power generation and photovoltaic power generation industry is taken as the alternative indicators of the new energy industry. At the same time, this paper uses the research method of Liang Huichao and other scholars (2017) for reference. They usually select the general equipment manufacturing industry, electrical machinery and equipment manufacturing industry as the alternative data because they do not directly reflect the data of wind power generation, photovoltaic power generation industry, especially the new energy industry. This paper uses the production and manufacturing links in the wind power and photovoltaic power generation industry chain to calculate the location quotient index. The production and manufacturing output value of these industries are generally concentrated in the general equipment manufacturing industry, electrical machinery and equipment manufacturing industry. Based on these industries, this paper selects the industrial output value and total output value of general equipment manufacturing industry, electrical machinery and equipment manufacturing industry in China, Shanghai, Jiangsu, Zhejiang and Anhui from 2010 to 2019, which can represent the output value of new energy industry to a certain extent, to calculate the location quotient and spatial agglomeration index of new energy industry in Yangtze River
3.2 Analysis of new energy industry cluster in Yangtze River Delta

The location quotient, Herfindahl coefficient, spatial Gini coefficient and spatial agglomeration index of new energy industry in four provinces and cities of Yangtze River Delta are calculated by using Excel. As shown in Table 1 and Table 2, the location quotient (LQ) of Shanghai shows a fluctuating downward trend, while that of Anhui shows a stable upward trend; The trend of Herfindahl coefficient (H) in Shanghai, Anhui and Zhejiang is relatively stable, Jiangsu has an upward trend in recent years; The spatial Gini coefficient (g) of Zhejiang tends to be stable, Shanghai and Anhui’s data tend to decline, while Jiangsu’s data tends to rise steadily. The base spatial agglomeration indexes (EG) of new energy industry in Yangtze River Delta are not high, but it shows a steady upward trend in 2017-2019, indicating that new energy industry has a trend of agglomeration under the rapid development of digitization in recent years.

Relying on abundant new energy research resources, talent support and technological advantages, Shanghai has initially formed an industrial cluster with mutual promotion of enterprises, R & D institutions and industrial alliance. However, due to the high location cost and the lack of policy perfection, the effect of industrial cluster is still not significant. The LQ index of new energy industry in Jiangsu showed a slow downward trend. Compared with other three provinces and cities, the agglomeration situation was better. Large enterprises such as Schneider and GCL were gathered, and new energy industrial parks were set up in Taizhou and Zhangjiagang; The LQ index of Zhejiang has been slightly higher than that of Shanghai and Anhui. To some extent, it benefits from the urgent demand of energy shortage, but there are still some problems, such as the low degree of product differentiation and the imperfect supporting public services.

| Area   | Year | Location quotient | Herfindahl coefficient | Gini coefficient |
|--------|------|-------------------|------------------------|-----------------|
| Shanghai | 2010 | 1.244383         | 0.000031               | 0.000119        |
|        | 2011 | 1.218085         | 0.000027               | 0.000085        |
|        | 2012 | 1.512377         | 0.000038               | 0.000442        |
|        | 2013 | 1.379692         | 0.000032               | 0.000240        |
|        | 2014 | 1.367592         | 0.000029               | 0.000208        |
|        | 2015 | 1.201661         | 0.000022               | 0.000063        |
|        | 2016 | 1.047595         | 0.000018               | 0.000004        |
|        | 2017 | 1.085787         | 0.000019               | 0.000012        |
|        | 2018 | 1.177884         | 0.000021               | 0.000049        |
|        | 2019 | 1.180321         | 0.000020               | 0.000048        |
|        | 2010 | 1.846187         | 0.000362               | 0.007607        |
|        | 2011 | 1.901896         | 0.000385               | 0.008668        |
|        | 2012 | 2.526944         | 0.000682               | 0.024918        |
|        | 2013 | 1.379692         | 0.000712               | 0.026395        |
|        | 2014 | 1.367592         | 0.000677               | 0.025430        |
|        | 2015 | 1.201661         | 0.000642               | 0.022340        |
|        | 2016 | 2.403777         | 0.000625               | 0.021324        |
|        | 2017 | 1.085787         | 0.000739               | 0.028221        |
|        | 2018 | 1.177884         | 0.000914               | 0.040382        |
|        | 2019 | 1.180321         | 0.001053               | 0.050584        |
|        | 2010 | 1.582676         | 0.000117               | 0.001581        |
|        | 2011 | 1.439697         | 0.000094               | 0.000876        |
|        | 2012 | 1.864977         | 0.000152               | 0.003278        |

1 Data sources: statistical bulletin of national economic and social development, China Industrial statistical yearbook and China Statistical Yearbook (2010-2019)
| Year | Spatial Agglomeration Index | Energy Dependence | The Level of Economic Development | Energy Consumption |
|------|-----------------------------|------------------|----------------------------------|-------------------|
| 2010 | 0.0093                      | 0.000148         | 0.003139                         | 0.003139          |
| 2011 | 0.0096                      | 0.000131         | 0.002744                         | 0.002744          |
| 2012 | 0.0281                      | 0.000114         | 0.001895                         | 0.001895          |
| 2013 | 0.0292                      | 0.000109         | 0.001661                         | 0.001661          |
| 2014 | 0.0279                      | 0.000102         | 0.001405                         | 0.001405          |
| 2015 | 0.0239                      | 0.000114         | 0.001907                         | 0.001907          |

Anhui

| Year | Spatial Agglomeration Index | Energy Dependence | The Level of Economic Development | Energy Consumption |
|------|-----------------------------|------------------|----------------------------------|-------------------|
| 2010 | 0.0093                      | 0.000001         | 0.000546                         | 0.000546          |
| 2011 | 0.0096                      | 0.000001         | 0.000516                         | 0.000516          |
| 2012 | 0.0281                      | 0.000003         | 0.000351                         | 0.000351          |
| 2013 | 0.0292                      | 0.000003         | 0.000347                         | 0.000347          |
| 2014 | 0.0279                      | 0.000003         | 0.000340                         | 0.000340          |
| 2015 | 0.0239                      | 0.000002         | 0.000361                         | 0.000361          |
| 2016 | 0.0291                      | 0.000003         | 0.000347                         | 0.000347          |
| 2017 | 0.0413                      | 0.000004         | 0.000307                         | 0.000307          |
| 2018 | 0.0517                      | 0.000003         | 0.000347                         | 0.000347          |
| 2019 | 0.0413                      | 0.000004         | 0.000307                         | 0.000307          |

Table 2 Spatial agglomeration index of new energy industry in Yangtze River Delta

| Spatial Agglomeration Index | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|-----------------------------|------|------|------|------|------|------|------|------|------|------|
| Yangtze River Delta        | 0.0093 | 0.0096 | 0.0281 | 0.0292 | 0.0279 | 0.0239 | 0.0226 | 0.0291 | 0.0413 | 0.0517 |

4. Analysis of the formative factors of the formation of new energy industry cluster in the Yangtze River Delta

4.1 Establishment of index system

Based on the relevant research results of the influencing factors and location factors of the formation of new energy industry cluster, combined with the special consideration of new energy industry, this paper divides the important influencing factors of the formation of new energy industry cluster into two parts: location factors and supporting factors. The index system is shown in Table 3.

| Objective | Sorts | Factors | Proxy variable |
|-----------|-------|---------|----------------|
| Region Elements | Energy dependence | The level of economic development | EC: Energy consumption |
| Energy dependence | The level of economic development | GDP: Gross Regional Product |
| Market demand | The level of technological innovation | NE: Cumulative installed capacity of wind power |
| Investment in science and technology | PT: Number of effective invention patents of industrial enterprises |
| | RD: Number of R & D projects of Industrial Enterprises above Designated Size |

4.2 The establishment of the model

Now, the four provinces and cities of Yangtze River Delta are taken as different cross-sections, and the
panel data model is constructed to analyze the differences and correlations between sections, that is to explore the formation factors within each region. The formula is as follows:

\[ LQ_{it} = a_i + \beta_1 \times EC_{it} + \beta_2 \times GDP_{it} + \beta_3 \times NE_{it} + \beta_4 \times PT_{it} + \beta_5 \times UEF_{it} + \beta_6 \times RD_{it} + u_i + \epsilon_{it} \]

Attention: the subscript \( i \) represents three regions, assigned 1, 2, 3 and 4, which are Shanghai, Jiangsu, Zhejiang and Anhui respectively; The subscript \( t \) represents the year, and the assigned values are 1, 2, 3,... 10, which are 2010-2019 respectively; \( LQ = \) location quotient; and satisfies the assumption that the mean is zero and the same variance.

4.3 Data sources
The panel data are formed by using the statistical data of Shanghai, Jiangsu, Zhejiang and Anhui in 2010-2019. The data are respectively from China Statistical Yearbook, China Energy Statistics Yearbook, China Environmental Yearbook and renewable energy data manual.

4.4 Regression analysis on the formation factors of new energy industry cluster
This paper uses the panel model analysis method of Stata software to make a comprehensive regression and Analysis on the influencing factors of the formation of new energy industry cluster. OLS (least square regression) regression analysis was performed, the analysis results are shown in Table 4. The results show that energy dependence (EC), economic development level (GDP), R&D level (RD) and regression effect are significant. The three proxy variables are significant and the model panel regression formula is \( LQ = 0.897 + 0.14875 \times EC - 0.0000001 \times GDP - 0.0007882 \times NE - 0.0341215 \times PT + 0.10233 \times RD \).

That is to say, for every 1% increase in R&D level, location quotient increases by 0.102%, indicating that R&D level and R&D investment promote the formation of new energy industry cluster. When the energy demand index increases by 1%, the location quotient increases by 0.1488%, which indicates that the regional energy demand drives the formation of new energy industry agglomeration effect.

| Table 4 Regression results of factors’ influence |
|-----------------|-----------------|-----------------|
| Variables       | OLS             |                 |
| EC              | 0.612**         | (2.380)         |
| GDP             | 0.000**         | (2.680)         |
| NE              | 0.000           | (0.332)         |
| PT              | 0.015           | (0.721)         |
| RD              | 0.058*          | (1.820)         |
| Constant        | 1.085**         | (7.348)         |
| R-squared       | 0.137           |                 |

The p value of F test is 0.0061, it is reasonable to reject the original hypothesis and OLS model is valid.

5. Conclusion

5.1 The location factors on the formation of new energy industry cluster
From the results of empirical analysis, it can be seen that the energy dependence and the level of economic development play an important role in promoting the formation of new energy industrial clusters in the Yangtze River Delta.

The energy dependence of the Yangtze River Delta has a significant effect on the formation of new energy industry agglomeration. Compared with traditional energy, new energy is more easily accepted...
by the general direction of ecological protection in China. Therefore, the level of economic development has a significant impact on the formation of new energy industry cluster. The structure of energy industry in economically developed areas has been relatively formed, and its capital status, infrastructure and policy frontier are relatively better. In addition, the lack of core technology and repeated construction of new energy industry also need a good economic foundation to make up.

5.2 The supporting factors on new energy industry cluster

There is a positive correlation between the level of science and technology investment and the formation of new energy industry cluster. The results show that the formation and development of new energy industry cluster is largely supported by the level of science and technology, R & D capability and digital development in manufacturing era. This is reflected in the development planning guidance, policies and measures of the Yangtze River Delta.

It is mentioned in the 13th five year plan and the 14th five year plan of the State Council that the country takes digitization as an important strategic means to promote economic and social development. At the same time, the support and development of science and technology promote and drive the development of new energy industry cluster, so that it can share the labor market, related technology and infrastructure construction achievements in the same region.

The outline of the Yangtze River Delta regional integration development plan clearly proposes to build a "digital Yangtze River Delta". It is mentioned that leading enterprises should be supported to integrate research forces of scientific research institutes across regions; Support leading enterprises and scientific research institutions to establish new R & D platforms such as artificial intelligence in the Yangtze River Delta and how to make good use of these plans is worth further thinking.

References

[1] Guo Liwei, Shen Manhong. Identification and evaluation of new energy industry cluster level based on location quotient and ness model: a case study of Zhejiang Province [J]. Science of science and technology management, 2013, 34 (05): 70-79

[2] Fei Li,Fu Zhou Luo,Zhi Liu,Yan Cheng Li. Based on the Identification and Location Quotient Measure Law CES Yulin New Energy Industry Clusters and Analysis[J]. Applied Mechanics and Materials, 2015, 3830.

[3] Liang Huichao, Cui Ting, Sun Liyun. Analysis on the influencing factors and path of the formation of Beijing Tianjin Hebei new energy industry cluster [J]. Economic perspective, 2017 (06): 17-25

[4] Wheeler, C.H. (2009), Technology and industrial agglomeration: Evidence from computer usage*. Papers in Regional Science, 88: 43-62.

[5] Zhang Lang, Liu Qingxiu. Economic distance, Circulation Innovation and economic spatial spillover effect of industrial clusters: a case study of the Yangtze River economic belt [J]. Commercial economy research, 2021 (10): 152-155

[6] Liu Hui. The impact and spatial effect of producer services agglomeration on carbon emissions in the Yangtze River Delta Urban Agglomeration: an econometric analysis based on Panel Data [J]. Business economics research, 2017 (17): 166-168

[7] Tang ZhaoPei, Wu Wei, Liu Weichen, Li Xiaoli. The impact of high speed railway on the spatial agglomeration of producer services: a case study of the Yangtze River Delta urban agglomeration [J]. Progress in Geographical Sciences, 2021,40 (05): 746-758