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# Research on Regional Differentiation Effect of Manufacturing Intelligence on the Optimization Manufacturing Structure

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***Abstract:*** With the popularity of intelligent application, the intellectualization has important strategic value to transform our country to a manufacturer of quality. As high-end, intelligent, green service-oriented manufacturing industry has become the main development direction of manufacturing, the intelligence upgrading of traditional industry is of great urgency. However, the growth of manufacturing in different regions of our countries has not been uniform, so the level of intelligence development of manufacturing industry in different regions also varies greatly. In this context, how to give full play to the influence of manufacturing intelligence on the optimization of manufacturing structure has become the key content to realize the high-quality development of manufacturing industry. In view that there are fewer path research results of manufacturing intelligence on the optimization of manufacturing structure currently, this paper taking the eastern, central, western and northeastern regions as the research horizon, this paper concludes the realistic situation of the influence of the manufacturing intelligence on the optimization of manufacturing structure in different regional backgrounds, hoping to provide beneficial help for the balanced and high-quality development of China's manufacturing industry,

***Keywords:*** Optimization of Manufacturing Structure; Manufacturing Intelligence; Test Mechanism; Regional Differentiation

## 1. Literature Review

The influence of manufacturing intelligence on the optimization of manufacturing structure mainly focuses on the following contents: definition of manufacturing intelligence, the biased technological progress in manufacturing and the direct influence of manufacturing intelligence on the optimization of manufacturing structure with less attention to the specific path research of manufacturing intelligence to manufacturing structure optimization. Some scholars have studied the direct effect of biased technological progress represented by intellectualization on manufacturing structure from the logical starting point of intellectualization of manufacturing industry. For example, Liu Liang et al. (2020) [1] explored the direct influence of intelligence on production capacity through biased technological progress by constructing CES function and utilizing biased technological progress. However, Li Jianxuan (2020) [2] measured the causes and degrees of regional differentiation of manufacturing intelligence in China from three aspects: intelligent technology, intelligent application and intelligent benefit. Some scholars also started from a micro perspective, taking Wen Huwei (2021) [3] as an example. He analyzed the effect of manufacturing intelligence on the production efficiency of manufacturing enterprises and explored the micro-mechanism and formation basis by using empirical methods.

As the intelligent applications of manufacturing deepens, the eastern region is steadily promoting industrial transformation and upgrading, while the central and western regions are actively undertaking industrial transfer. Therefore, it is particularly critical to optimize the structure of regional manufacturing industry and explore the role of intellectualization in it. The marginal contributions of this paper are as follows: giving the path influence of manufacturing intelligence on

manufacturing structure optimization from the regional perspective, and the introduction of the northeast region of regional analysis, reasonable exploration of regional development differences.

## 2. Mechanism Analysis

The growth of the intelligence level of manufacturing industry will further replace the original input level of human capital, and effectively improve the production efficiency of the manufacturing industry, thus promoting the optimization of the overall level of the manufacturing industry. However, due to the differences of the manufacturing development in different regions, it is difficult to implement unified government policies. On this basis, this paper proposes the research hypotheses. For one thing, the improvement of manufacturing intelligence stimulates factors of production to transform to the upper arm, improves the level of manufacturing industry structure, and clears the productive factors of the original "zombie companies" to achieve effective communication between supply and demand information and enhance the level of manufacturing structure rationalization by technology innovation. The following research hypotheses are proposed on this basis: The intellectualization of manufacturing industry will effectively promote the optimization of manufacturing industry structure and improve the manufacturing structure supererogation and rationalization.

## 3. Empirical Analysis and Data Explanation

## 3.1 Index Selection and Explanation

### 3.1.1 Predicted Variables

The predicted variable is the degree of optimization of manufacturing structure, which is a process of dynamic evolution and reflects the overall state of the development of manufacturing industry. In order to better measure the overall process of optimization of manufacturing structure, this paper selects manufacturing structure supererogation and manufacturing structure rationalization to measure.

Manufacturing structure supererogation (hsm): Manufacturing structure supererogation reflects the upward trend of manufacturing structure, that is, the law of change to technology-intensive industry. It plays a key role in further improving the output capacity of high-end manufacturing products. This paper uses Fu Yuanhai et al. (2014) [4] for reference. They divided the manufacturing industry into high-end, mid-end and low-end manufacturing. Combined with the classification method of OECD, the author adopts the proportion between high-end output value and mid-end output in the manufacturing industry to measure the level of manufacturing structure supererogation.

Manufacturing structure rationalization (theil): Manufacturing structure rationalization reflects the correlation among enterprises in manufacturing industry and the coupling and synergistic relationship between input and output. Taking the practice of Gan Chunhui (2011) [5] for reference, the author adopts Theil Index to measure the rationalization level of manufacturing structure. The formula is as follows:

$$theil = \sum_{i=1}^{n} \left(\frac{Y_i}{Y}\right) ln \left(\frac{\frac{Y_i}{L_i}}{\frac{Y}{L}}\right) \quad (1)$$

### 3.1.2 Explanatory Variables

Core explanatory variable is intellective level of manufacturing industry. Referring to the indicator division method of Zhao Yuhui (2019) [6], this paper calculates the manufacturing intelligence from three levels: intelligent base layer, software application layer and market practice layer. The specific division method is shown in Table 1:

**Table 1:** Intelligent evaluation index system of manufacturing industry

| major index | First grade indicators | Second grade indicators | Measurement index | Units of the index | Index attributes |
|---|---|---|---|---|---|
| Index of manufacturing intelligence | Intelligent base indicators | R & D expenditures and equipment investment | Credit, accounting, software industry fixed investment level | Ten thousand | Positive |
| | | Intelligent input | Development expenditure of new products of electronic and communication equipment manufacturing | Ten thousand | Positive |
| | Software application indicators | Software development | Total number of software enterprises | Pcs | Positive |
| | | Software maintenance | Software revenue | Ten thousand | Positive |
| | Market practice indicators | Market profit of intelligent device | Electronics and communication equipment manufacturing profits | One hundred million | Positive |
| | | Market efficiency of intelligent device | Electronics and communication equipment manufacturing prime operating revenue of the year / Employment figure of the industry | Ten million/person | Positive |

In this paper, the entropy method is adopted for calculation. In the entropy method, the greater the degree of data dispersion is, the greater the development gap between regions is, which objectively shows the importance of indicators. Otherwise, the smaller the degree of data dispersion is, the smaller the development gap between regions is.

### 3.1.3 Controlled Variables

According to the above measurement model, the controlled variables mainly include: a. transport infrastructure, measured by the sum of roads and railways mileage per square kilometer in each province; b. industrial scale, measured by the proportion of total investment in fixed assets taking in GDP of the whole society; c. the degree of opening up, measured by the proportion of the actual total imports and exports taking in GDP of each provincial administrative region. d. the level of financial development, measured by the ratio of the added value of the financial industry and the tertiary industry in each provincial administrative region; e. the level of human capital, measured by the proportion of the number of students in universities and colleges taking in the number of permanent residents at the end of the year.

## 3.2 Model Building

In this paper， the panel data of 27 provincial-level administrative regions (except Xinjiang, Tibet, Ningxia, Qinghai, Hong Kong, Macao and Taiwan) are selected to conduct empirical analysis by constructing an econometric model to test the influence of intelligent manufacturing level on the optimization of manufacturing structure. The specific model is set as follows:

$$hsm_{i,t} = \alpha_0 + \alpha_1 intelligence_{i,t} + \alpha_2 infra_{i,t} + \alpha_3 scale_{i,t} + \alpha_4 open_{i,t} + \alpha_5 fin_{i,t} + \alpha_6 hum_{i,t} + \varepsilon_{i,t} + \mu_{i,t} + \delta_{i,t} \quad (2)$$

$$theil_{i,t} = \alpha_0 + \alpha_1 intelligence_{i,t} + \alpha_2 infra_{i,t} + \alpha_3 scale_{i,t} + \alpha_4 open_{i,t} + \alpha_5 fin_{i,t} + \alpha_6 hum_{i,t} + \varepsilon_{i,t} + \mu_{i,t} + \delta_{i,t}$$

(3)

Referring to the measurement of manufacturing structure optimization by Fu Yuanhai et al. (2014) [4], this paper chooses to measure it from two dimensions: manufacturing structure rationalization and manufacturing structure supererogation.

## 3.3 Data Sources

Due to the serious lack of manufacturing data in four provinces like Xinjiang, Tibet and so on, this paper selects panel data of 27 provincial administrative regions (except Xinjiang, Tibet, Ningxia, Qinghai, Hong Kong, Macao and Taiwan) from 2009 to 2019 for research. The data are mainly from *China Statistical Yearbook*, *China Statistics Yearbook on High Technology Industry* and the statistical yearbooks of provinces and cities, supplemented by the difference method and trend inference method.

# 4. Empirical Results Analysis

In this paper, the panel data of the eastern, central, western and northeastern regions are regressed. The results are shown in Table 2. In manufacturing structure supererogation to be explained variables in the regression results, the regression results of four regions all passed the significance test of 1%. The regression results showed that the manufacturing intelligence exerted significant positive correlation on manufacturing structure supererogation in the eastern, central and western regions. However, the regression coefficient of northeastern region presented a significantly negative relationship. Based on the lag term of manufacturing intellectualization construction in northeast China, the author found that when there was a lag of 3 to 4 periods, manufacturing intellectualization had a positive impact on manufacturing structure supererogation, which indicated that the northeast traditional industry took a large proportion, industrial transformation and upgrading was difficult, and the effect of intellectualization on industrial transformation was not easy to appear in the short term. In order to test its robustness, the author observed the influence of the addition of the current manufacturing intelligence level during the three lag periods and found that there was no significant impact on the manufacturing intelligence level during the three lag periods. The regression result passed the significance test of 1%. In the regression results of manufacturing structure rationalization as the explained variable, the regression results of eastern, central and western regions passed the significance test of 1%. While the coefficient sign in northeast region was negative, but it was not significant, which indicated that the intellectualization of manufacturing industry would also improve the rationalization level of manufacturing structure in northeast China. In the western region, the level of intellectualization of manufacturing industry has a significant positive impact on the level of rationalization of manufacturing industry structure by 8.35%. The above conclusions are consistent with hypothesis of this paper.

**Table 2:** Direct influence of manufacturing intellectualization on manufacturing structure optimization in four regions

| The variable name | Manufacturing structure supererogation | | | | Manufacturing structure rationalization | | | |
|---|---|---|---|---|---|---|---|---|
| | eastern region | central region | western region | Northeast region | eastern region | central region | western region | Northeast region |
| lnIntelligence | 2.743*** | 5.883*** | 4.165*** | -8.384*** | -2.547*** | -1.717*** | -8.356*** | -0.272 |
| | [0.266] | [1.751] | [0.448] | [2.476] | [0.247] | [0.652] | [1.216] | [1.363] |
| lninfra | -0.13 | 0.348*** | 0.554*** | -0.097 | -0.996*** | -0.153 | -0.122 | -1.576 |
| | [0.294] | [0.110] | [0.117] | [2.225] | [0.209] | [0.511] | [0.103] | [2.389] |
| scale | -4.610*** | 0.4 | -0.814* | 4.175*** | -1.666*** | 0.175 | 0.856 | -1.025*** |
| | [0.552] | [0.250] | [0.422] | [1.175] | [0.207] | [0.212] | [0.527] | [0.353] |
| open | -9.229*** | -4.46 | 28.982*** | -6.087* | 6.259*** | 11.954 | 11.212 | -0.165 |
| | [2.627] | [9.709] | [5.092] | [3.333] | [0.576] | [11.533] | [6.743] | [1.148] |
| fin | 13.966*** | -3.882** | 9.200** | 13.594 | -8.045*** | -0.398 | -4.504 | 11.908*** |
| | [1.874] | [1.710] | [3.791] | [11.640] | [1.749] | [1.635] | [3.024] | [3.987] |
| hum | -0.444 | 1.306 | 14.472* | 107.625** | 36.617*** | 71.805** | 28.997** | 10.383 |
| | [6.782] | [19.004] | [7.649] | [35.073] | [6.904] | [31.047] | [10.956] | [11.034] |
| _cons | 13.564*** | 17.939** | 9.231*** | -50.658** | 0.479 | -7.809 | -30.157*** | 8.683 |
| | [3.206] | [6.976] | [1.526] | [16.661] | [2.344] | [5.396] | [3.707] | [21.660] |
| *N* | 110 | 66 | 88 | 33 | 110 | 66 | 88 | 33 |

Note: ***, ** and * are significant at the levels of 1%, 5% and 10% respectively.

The data source is collated and calculated in this paper.

# 5. Conclusion

Due to the different actual conditions of manufacturing industry in the eastern, central, western and northeastern regions, local governments in each region will show regional differences in the process of using environmental regulation as a policy tool to govern the environment. Improving the level of environmental regulation can effectively enhance the level of manufacturing industry in eastern and central areas, which indicates that the factors of production will automatically shift to high-end manufacturing. However, due to “siphon” effect on the factors of production in the eastern region, the total factor is enough. Thus, the improvement of environmental regulation level will effectively promote the level of manufacturing structure rationalization. However, the total amount of factors in the central region is relatively insufficient, so the improvement of environmental regulation level will squeeze the space for factors to transfer to the mid-end and low-end manufacturing industry. There are a large number of traditional manufacturing industries in the western and northeastern regions. So, if the government strengthens environmental regulation in the short term, it would be easy to hinder the optimization of manufacturing structure. In order to develop the local economy, local governments often take measures to optimize the business environment, so the optimization of the business environment is often used as an exogenous policy variable to influence the optimization of local manufacturing structure. The improvement of marketization will effectively optimize the structure of eastern manufacturing industry and improve the level of manufacturing structure supererogation and rationalization. In recent years, under the influence of the “westward migration” of the manufacturing industry, the improvement of the marketization level in the western region will also attract manufacturing enterprises. Therefore, the improvement of the marketization level in the western region will optimize the manufacturing structure and improve the level of manufacturing structure supererogation and rationalization. The influence of marketization on the central region is consistent with the above analysis. Due to the limitation of the total amount of factors, the downward flow space of factors

will be squeezed. When the northeast region improves the level of marketization, the northeastern region will have the trend of downward flow of factors, which will squeeze the space of upward flow of factors and make factors flow to low-end manufacturing. Overall, the behavior of carrying out the marketization policy of factors of production by the local government will effectively promote the optimization of local manufacturing industry structure. However, the northeastern region is limited by the number of factors of production and trapped in the realistic difficulties of heavy industry transformation and upgrading, so policy of carrying out marketization of factors of production in northeastern region will make factors show the trend of upward “squeeze”.

# Project:

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