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# The Impact of Human Capital on the High Quality Development of Manufacturing

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***Abstract:*** *Based on the panel data of 30 provinces, cities and autonomous regions in China from 2011 to 2020, the entropy method was used to measure the index of manufacturing quality development in each region, and the impact of human capital on the quality development of manufacturing industry was explored through Tobit regression model. The results indicate that human capital has a positive and significant impact on the high quality development of manufacturing industry; overall, Beijing has the most advanced level of high quality development of manufacturing industry, while Xinjiang has the least. There is a significant negative relationship between the level of economic development and import and export scale and the level of manufacturing quality development. Based on this, several suggestions are made for the future development of high quality manufacturing.*

***Keywords:*** *Human Capital, High Quality Development of Manufacturing, Entropy Method, Tobit Regression Model*

## 1. Introduction

### *1.1 Research Background*

The report of the 20th Organization Congress mentions that it will deeply implement the strategy of strengthening the country with talents and accelerate the construction of a world important talent center and innovation highland. As a result, accelerating human capital investment and improving the level of human capital has become a major strategic task for China's current and future high-quality economic and social development. Now human capital is undergoing the transformation from "population dividend" to "talent dividend", and as the core subject of innovation, the level of human capital plays a pivotal role in the improvement of the country's comprehensive national power.

General Secretary pointed out in the report of the 19th Organization Congress that "China's economy has shifted from the stage of high-speed growth to the stage of high-quality development, and is in the critical period of transforming the mode of development, optimizing the economic structure and changing the growth momentum, and high-quality economic development will become the new normal of China's economic development in the future. As the core component of the real economy, the manufacturing industry is the root of a strong country and the main force of high-quality development. As a result, the high quality development level of manufacturing industry profoundly influences the process of China's transformation from a large manufacturing country to a strong manufacturing country, and is of great significance to China's economic development.

However, at present, there are still some problems in the high quality development of China's manufacturing industry, and the human capital factor is one of them. The high-quality development of manufacturing industry is greatly impacted by the level of human capital, thus making it of great practical importance to investigate.

### *1.2 Connotation of Human Capital*

Human capital in a broad sense refers to the combination of knowledge, qualities and abilities attached to the human body that have economic value, including production skills, organizational skills, psychological qualities and health standards. As one of the most critical factors of production, human capital plays a vital role in economic development, and Lucas argues that human capital is the key to promoting innovation and achieving sustained economic growth. Lin, Yong and Zhang, Jie argue that for developing countries, under a good system human capital becomes an important factor in promoting

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science and technology innovation, and plays an important role in narrowing the economic development gap between different countries [1]. Li, Yong and Duan, Shi-Ning argue that a large number of highly educated people in China are excessively deposited in the public service sector and state-owned monopolies, and there is a shortage of human capital in the more market-oriented productive and innovative sectors [2].

Nowadays, China is at a critical point of innovation and development, and the Organization and government emphatically declared in the "Proposal of the Central Committee of the Communist Organization of China on the 14th Five-Year Plan for National Economic and Social Development and the 2035 Vision" that "we should adhere to the strategy of innovation-driven and talent-strong country, stimulate the innovative vitality of talents, and comprehensively shape new advantages in development.". This clearly demonstrates China's determination to develop human capital. This shows that human capital is the capital embodied in workers, and is one of the vital factors of production.

### *1.3 High Quality Development of Manufacturing*

At present, the definition of quality manufacturing development is still being explored by the theoretical community. Yang Wu argues that high quality manufacturing development is mainly a service-oriented transformation of the manufacturing industry, bundling core products with corresponding knowledge, technology and services in order to increase their value [3]. Lina Gao and Huiyong Song argue that independent innovation plays an important role in shaping the endogenous dynamics of China's high-quality manufacturing development [4]. Zhang Panfeng and Zhang Jianqin argue that high-quality development of the manufacturing industry requires high product quality, green production processes, increased value-added products and increased international competitiveness [5].

To conclude, quality manufacturing development is characterized by the highest quality of product, production process, enterprise effectiveness, and global competitiveness; innovation is the key to furthering the high quality growth of China's manufacturing sector.

### *1.4 Relevant studies on the impact of human capital on quality development in manufacturing*

(1) The impact of human capital on innovation performance in manufacturing

Li Hongchen and Cao Hongjian examined the impact of human capital expansion on the innovation performance of China's manufacturing industry by constructing a quasi-natural experiment conducted through the university entrance examination expansion policy revealed that human capital expansion had a remarkable effect on the innovation performance of China's manufacturing industry, thus providing policy insights for the high-quality development of manufacturing industry in the context of college expansion. [6].

(2) The impact of human capital on manufacturing upgrading

Wu, Wenjie, Zhang, Yanfei, and Wang, Yu developed a panel model based on data from China's manufacturing industry segments and conducted an empirical analysis, showing that human capital can drive manufacturing upgrading at the national level, but its role is limited, and that there is regional heterogeneity in the impact of human capital on manufacturing upgrading by region[7].

(3) The impact of human capital structure on quality development in manufacturing.

Yang, Renfa and Zheng, Yuanyuan analyse the impact of human capital structure on the quality development of the manufacturing industry by examining provincial panel data in China from 2006 to 2019. The study found that: the improvement of human capital structure can enhance the high quality development of manufacturing industry [8].

Therefore, based on the panel data of 30 provinces, cities and autonomous regions from 2011 to 2020, this paper provides an intensive analysis of the impact of human capital on the high quality development of manufacturing industry through Tobit regression model and entropy value method. It also provides some references for China to enhance the process of high quality manufacturing industry development.

ISSN 2616-5902 Vol. 5, Issue 12: 122-127, DOI: 10.25236/AJBM.2023.051221

## 2. Model construction

### *2.1 Tobit regression model*

In order to study the impact of demographic capital on quality manufacturing development, this paper analyses the factors influencing it based on the Tobit regression model. Its basic structure is as follows.

$$Y_h = \begin{cases} \beta x + \alpha, \beta x + \varepsilon > 0 \\ 0, \beta x + \varepsilon \le 0 \end{cases} \tag{1}$$

Where: $Y_h$ is the Manufacturing Quality Development Index; $\beta$ is the parameter to be estimated; $x$ is the explanatory variable; $\varepsilon$ is the random disturbance term, independent and satisfying $\varepsilon \sim (0, \sigma^2)$

### *2.2 Entropy value method*

The entropy method, which is commonly employed in the objective weighting approach, is thus utilized in this study to gauge the level of quality advancement in the manufacturing sector. The data are processed according to the entropy method, and the weights of each indicator are calculated to measure the comprehensive index of the sample:

$$\begin{cases} Y_{it} = \sum_{j=1}^{n} W_j \times x'_{ij} \\ i = 1, 2, \cdots, 30;\ j = 1, 2, \cdots, 19 \\ t = 2011, 2012, \cdots, 2020 \end{cases} \tag{2}$$

$Y_{it}$ is the manufacturing quality development index of a province, municipality or autonomous region in a given year, $x'_{ij}$ is the standardized value, $W_j$ is the indicator weight, $t$ represents the year, $j$ represents the indicator and $i$ represents a province, municipality or autonomous region. The size of the composite index determines the level of quality development of manufacturing in a province, city or autonomous region; the higher it is, the higher the level of quality development of manufacturing.

### *2.3 Description of variables*

(1) Explanatory variable: level of quality development in manufacturing (hqdm)

This paper refers to the evaluation index system of high-quality development of manufacturing industry constructed by Zhang Li and Zhu Na, and combines the connotation of high-quality development of manufacturing industry to construct the evaluation index system of high-quality development of manufacturing industry from the aspects of product quality, production process, enterprise efficiency and international competitiveness [9]. In this paper, the four aspects of strategy, production input, production process and output are integrated to build an evaluation index system of manufacturing high-quality development covering 8 guideline level, including 14 primary indicators and 19 secondary indicators. The detailed information is shown in Table 1.

(2) Explanatory variable: human capital (hu)

This paper considers the availability of data at the provincial level and draws on existing research findings to select the number of university students as an indicator of human capital. The amount of university students is a measure of human capital due to their remarkable knowledge and aptitude, which is in accordance with the fundamental features of human capital.

(3) Control variables

The following control variables are introduced in this paper to ensure robustness of the results,: level of economic development (pgdp), measured by the natural logarithm of GDP per capita; level of investment in education (edu), measured as a proportion of public general expenditure on education; size of exports and imports (exim), which is measured as a proportion of total exports and imports to GDP; and population density (popdens), measured by the natural logarithm of land area per capita.

ISSN 2616-5902 Vol. 5, Issue 12: 122-127, DOI: 10.25236/AJBM.2023.051221

*Table 1: Manufacturing quality development evaluation index system*

| Guideline level | Primary indicators | Secondary indicators | Properties |
|---|---|---|---|
| Strategic Foundations | Strategic Foundations | Industrial value added | + |
| Elemental inputs | Labour input | Number of people employed in manufacturing | + |
| Innovation driven | Innovative environment | Share of science and technology expenditure | + |
| | Innovation input | R&D staff input intensity in manufacturing | + |
| | | R&D investment intensity in manufacturing | + |
| Structural optimisation | Industrial structure | Share of main business income from high-tech industries | + |
| | Product structure | Percentage of revenue from new product sales | + |
| | Export structure | Share of exports of high-tech products | + |
| Green development | Solids pollution | Solid waste emission intensity | - |
| | Wastewater pollution | Wastewater discharge intensity | - |
| | Atmospheric pollution | Exhaust emission intensity | - |
| Integrated development | Integration of two cultures | Internet penetration rate | + |
| | | Share of mobile phone subscribers | + |
| Innovative results | Innovative outputs | Number of R&D expenses per unit of patent | - |
| | | Number of patents granted per R&D personnel | + |
| | | Technology market turnover per R&D personnel | + |
| Social effects | Environment | Percentage of expenditure on environmental protection | + |
| | Employment | Number of persons employed in industry as a percentage | + |
| | | Average wage growth of employed persons | + |

(4) Model construction

Based on the above description of the explanatory variables as well as the control variables, the corresponding Tobit regression models were further developed as follows.

$$y_h = \beta_0 + \beta_1 hu + \beta_2 pgdp + \beta_3 edu + \beta_4 exim + \beta_5 popdens + \varepsilon \quad (3)$$

(5) Data sources

For this study, 30 provinces, municipalities and autonomous regions (except Tibet) were selected for the study, spanning the period 2011-2020. The data was sourced from the China Statistical Yearbook, China Industrial Statistical Yearbook, China Science and Technology Statistical Yearbook, Guotaian database, and statistical yearbooks of pertinent provinces. Individual data for individual years are lost, and this paper uses the mean value method and interpolation method to make up for this.

## 3. Empirical analysis

### *3.1 Analysis of empirical results*

In this paper, the Tobit model established above was regressed with the help of StataMP 17 software, where some of the data were taken as logarithms to avoid data bias caused by extreme values, and the results are shown in Table 2 Model (1).

From the model (1) in Table 2, it can be observed that human capital is positively related to the level of quality development in manufacturing, and it is significant at 1% level, which indicates that the enhancement of human capital significantly promotes the high quality development of manufacturing industry. This implies that the improvement of human capital significantly promotes the high quality development of manufacturing industry. Firstly, the improvement of human capital can provide manufacturing enterprises with higher quality talents, and high quality talents can help the development of enterprises from R&D, management, production and other aspects, helping manufacturing enterprises to develop in a high quality way. Secondly, the manufacturing industry's innovation development can be furthered by the enhancement of human capital, which is a fundamental element of innovation. This can then encourage each manufacturing enterprise to create new products, augmenting their value, and ultimately foster the high-quality development of the industry.

ISSN 2616-5902 Vol. 5, Issue 12: 122-127, DOI: 10.25236/AJBM.2023.051221

*Table 2: Tobit regression results*

| Variables | Tobit | |
|---|---|---|
| | (1) | (2) |
| lnhu | 0.7845*** | 0.5091*** |
| | (0.2047) | (0.1974) |
| lnpgdp | -0.4287*** | -0.3209*** |
| | (0.0445) | (0.0510) |
| edu | 5.4401*** | 4.3116*** |
| | (0.7733) | (0.9164) |
| exim | -0.2031** | -0.2143* |
| | (0.1104) | (0.1273) |
| lnpopdens | 0.3608*** | 0.2878** |
| | (0.1383) | (0.1315) |
| sigma_u | 0.9398*** | 0.88645*** |
| | (0.1292) | (0.1210) |
| sigma_e | 0.1382*** | 0.1175*** |
| | (0.0060) | (0.0058) |
| LR | 483.92*** | 394.05*** |

Pour: *. **. ***Represents the significance levels at 10%, 5%, and 1%, respectively.

A negative correlation between economic growth and quality manufacturing development is evident, with a 1% significance level, suggesting that the level of economic development has an adverse effect on quality manufacturing development. The tertiary sector's prosperity may be more relied upon by cities with higher economic development, thus diminishing the reform and development of the manufacturing sector, leading to a negative correlation between economic growth and the quality of the manufacturing sector

The level of investment in education is positively correlated with the level of high quality development of the manufacturing industry and is significant at the 1% level, indicating that investment in education has a good promotion effect on the high quality development of the manufacturing industry. Investment in education not only has a greater impact on the level of education and the basic quality of a city's population, but also draws in foreign talent and labour, thus further promoting the quality development of the manufacturing industry.

At the 5% level, a significant negative correlation between the scale of imports and exports and the level of quality development in the manufacturing sector is demonstrated, demonstrating that the size of imports and exports has a negative effect on the quality development of the manufacturing sector. This situation is due to the fact that cities with large import and export scale will rely on the economic benefits brought by import and export and pay less attention to the transformation of manufacturing industry from high speed to high quality development, resulting in the manufacturing the high quality development of the manufacturing industry was inversely proportional to the magnitude of import and export.

Finally, the relationship between population density and the level of quality development of manufacturing industry shows a positive correlation and is significant at the 1% level. To a certain extent, this indicates that China's manufacturing industry is still dependent on population density and is still in the process of shifting from expansionary growth to innovation-driven quality development.

### *3.2 Robustness tests*

To ensure the stability of the results, data from the 2013-2020 section were selected for robustness testing in this paper. The results of the test are shown in part (2) of the model, and the regression coefficients are consistent in direction, indicating that the results are not chance.

## 4. Conclusions and recommendations

### *4.1 Conclusions*

This paper employs Tobit regression model to measure the manufacturing quality development index by entropy method, utilizing panel data from 30 provinces, cities, and autonomous regions (excluding Tibet) between 2011 and 2020. It further investigates the effect of human capital and related influencing factors on manufacturing quality development. The following are the findings: Human capital is a major factor in the advancement of quality manufacturing, followed by investment in education and population

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density, which have a significant positive correlation with the same. Conversely, economic development and the magnitude of imports and exports have a significant negative effect on the same.

### *4.2 Recommendations*

This paper proposes the following recommendations, based on the above discoveries.

Deepen the strategy of strengthening the country with talents and speed up the upgrading of human capital. The government should insist on implementing the strategy of strengthening the country with talents and accelerating the upgrading of human capital, as well as improving the talent training system to further promote the transformation of China's "demographic dividend" into a "talent dividend", thus helping to transform the manufacturing industry from high-speed development to high-quality development.

Promote the development of distinctive industries and upgrade the industrial structure Localities should pay more attention to local manufacturing industries, further promote the development of local special industries, combine local characteristics, economic conditions and high-tech technologies to create distinctive high-tech industries, thereby increasing the added value of local manufacturing products and accelerating the upgrading of manufacturing industry structures.

Sound talent management mechanism to adapt to the changes in economic development. According to the previous study, there is a certain negative correlation between economic development and high quality development of manufacturing industry. Therefore. Further sound talent management mechanism is conducive to the reasonable allocation of the limited amount of human capital and to make the high-quality development of manufacturing industry appropriate to the changes in human capital and economic development, so as to promote the high-quality development of manufacturing industry.

### *4.3 Outlook*

At the outset, the data's restriction renders the assessment of human capital in this paper rather broad. The amount of university students as a gauge has certain restrictions, and does not investigate the route of human capital for the high-grade advancement of the manufacturing sector, which has more restrictions and can be further investigated. Secondly, the data selected in this paper is from 2011 to 2020, which has a certain lag due to the technical level, and the amount of data can be increased in future studies to obtain more timely results.

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