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Manufacturing Industry Resource Endowment Index and Its Big Data Model

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Abstract: - This study aims to demonstrate the application of big data models in the evaluation of manufacturing competitiveness across different countries and economic entities. It involves analyzing algorithms and data structures, designing algorithms for evaluating manufacturing competitiveness suitable for different countries and economic entities, and providing algorithmic and theoretical support for building computer assessment models for manufacturing competitiveness in economic entities. The research adopts qualitative and quantitative methods, comparing and analyzing empirical data on manufacturing resource endowment and competitiveness in various countries, combining theoretical analysis and empirical data. By conducting a literature review and empirical research, relevant information and data are collected to establish the relationship between manufacturing resource endowment index and competitiveness. Through case studies and comparative research, this study explores the main factors affecting manufacturing competitiveness in different countries and their interrelationships. It confirms that the competitiveness of manufacturing industries in different countries is influenced by factors such as resource endowment. Further analysis quantifies the relationship between national manufacturing resource endowment and competitiveness, leading to the design of computer algorithms, data structures, and processing logic. The results demonstrate the significant role of resource endowment in manufacturing competitiveness, serving as a crucial basis for formulating comprehensive national strategies. The innovations of this study include: 1. Introducing the manufacturing resource endowment index as a key variable for evaluating competitiveness, enriching the content of competitiveness big data models. 2. Designing comprehensive data structures, algorithms, and processing logic for assessing manufacturing competitiveness from multiple perspectives. 3. In-depth analysis of the relationship and analytical methods between manufacturing strategies, resource endowment, and competitiveness, providing theoretical and model references for the design of computer big data operation platforms.

Keywords: Big Data Algorithms and Data Structures, Resource Endowment Index, International Competitiveness of Manufacturing Industry, O2O Platform.

I. INTRODUCTION

The application of computer and big data technology in constructing the manufacturing competitiveness assessment model brings significant value.[1] Firstly, it widens the data sources and analytical capabilities for evaluating manufacturing competitiveness from various perspectives.[2] Big data technology efficiently handles and analyzes vast amounts of manufacturing data to uncover patterns and trends for more precise decision support.[2,3] Secondly, the critical design and analysis of computer algorithms in the model effectively address complex manufacturing issues like resource optimization and production efficiency.[4] Proper algorithm selection and optimization improve the accuracy and efficiency of the evaluation model, providing precise competitiveness assessments.[5] Additionally, optimized data structures play a crucial role in organizing data effectively, enhancing the performance and stability of the evaluation model.[6] Overall, leveraging these technologies optimizes the assessment and analysis of manufacturing competitiveness.[7]

The manufacturing industry plays a crucial role in the development of countries and economies, particularly in its core value for competing for better status worldwide. Manufacturing is a key indicator of a country's economic strength and competitiveness.[8] Strong manufacturing capabilities enable a country to enhance production efficiency, reduce costs, attract international investments, achieve trade surpluses through exports, and drive rapid economic growth. Additionally, manufacturing serves as a cradle for technology, driving and nurturing technological innovations, enhancing industrial capabilities through research and development investments, and facilitating product upgrades and structural adjustments. Furthermore, manufacturing has an extensive industrial chain, providing diverse employment opportunities, improving the overall quality and skill level of the workforce, driving the growth of the service industry, increasing people's income, and maintaining social stability and harmonious development.[9]

However, the development of manufacturing industries faces challenges and dilemmas. International competition intensifies as developed countries grapple with rising labor costs and the transfer of traditional manufacturing to regions with lower labor costs. Technological barriers and innovation act as bottlenecks for

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developing countries in manufacturing due to the lack of technical workers and high-quality talents.[10] Domestic transformation and upgrading are challenging due to environmental pollution issues and stringent environmental protection requirements.[11] Expanding in international markets is difficult due to trade frictions and restrictions. The fragility of supply chains necessitates countries to strengthen independent innovation and supply chain management, increasing pressure on government governance.[12]

Addressing these challenges requires economies to strategically position the development focus of manufacturing industries at the national level. Quantitative tools and big data algorithms should be applied to analyze the current state of the manufacturing industry across economies. This study utilizes big data, economics, and management methodologies to analyze the laws of development in the manufacturing industry. Historical manufacturing data is statistically analyzed to identify the significant impact of resource endowment and characteristic elements on positioning manufacturing industry development. These serve as important indicators for formulating national and regional manufacturing development strategies and provide a mathematical model reference for designing O2O platforms. Theoretical research part involves reviewing relevant literature from domestic and international scholars, categorizing factors influencing manufacturing industry development through economic and management methodologies, identifying core influencing factors, and analyzing their changing patterns. Empirical research applies big data technology and historical practical data to validate core influencing factors and their developmental patterns. Ultimately, a big data model on manufacturing resource endowment and international competitiveness is designed, providing quantitative analytical tools for decision-making on manufacturing industry development. This research also explores the life cycle and driving factors of manufacturing industry development, serving as a theoretical and framework reference for future O2O platform designs.

II. Theoretical Research

The theoretical framework guiding the model for the allocation of environmental elements in the manufacturing industry draws primarily from contemporary economic theories and scholarly research. This study is underpinned by theories such as new economic geography, resource allocation theory, and innovation economics, among others.

A. Location Theory and New Economic Geography

Location theory underscores the significance of geographical positioning in shaping the competitive dynamics and operational efficiency of the manufacturing sector. Considering the diverse regional characteristics and spatial influences, optimizing the allocation of environmental elements is imperative to enhance the industry's competitiveness.[13]

New economic geography scholarship delves into the interplay between spatial factors and economic activities, highlighting how geographical context and regional attributes impact innovation dynamics, industrial clustering, and economic outcomes.[14] The model for allocating environmental elements in high-end manufacturing industries must account for spatial considerations, including proximity principles,[15] agglomeration effects, and localization advantages.[16]

B. Resource Allocation Theory

Resource allocation theory delves into the judicious distribution of scarce resources to maximize benefits.[17] Within the model for environmental element allocation in high-end manufacturing sectors, the strategic deployment of human capital, technological resources, financial assets, and materials is pivotal.[18]

C. Innovation Economics

Innovation economics examines the nexus between innovative endeavors, economic growth, and industrial advancement.[19] Innovation stands out as a key catalyst within the environmental element allocation model for high-end manufacturing industries, encompassing technological breakthroughs, product innovation, and transformative business models.[20]

D. Industrial Agglomeration Theory

Industrial agglomeration theory posits that fostering close-knit concentrations of related industries in specific locales can yield substantial economic dividends. By nurturing specialized manufacturing hubs within designated regions, synergistic industrial clusters can emerge, fostering collaborative innovation, and bolstering the overall competitiveness of the manufacturing landscape.[21]

E. Policy and Planning Theory

Policy and planning theory underscores the pivotal role of government intervention in crafting and implementing industrial policies and regional blueprints.[22] Through targeted policy interventions and strategic planning initiatives, governments can mobilize diverse resources, offer support mechanisms, and create an enabling ecosystem conducive to the manufacturing industry's growth and development.[23]

F. Dimensional Design of the Model Based on Theoretical Research

The viewpoints and analyses put forth by experts and scholars regarding the achievement of sustainable development in the manufacturing industry and the prosperity of regional economies offer diverse perspectives. They provide a theoretical foundation and methodological framework for the allocation of manufacturing industry resources and the development of data models. This aids in enhancing our understanding and analytical capabilities concerning the manufacturing potential of different regions, as well as the formulation of resource and environmental element allocation strategies, along with the impact factors of relevant policies and supportive measures .[13,24]

Building upon the aforementioned theories, this study constructs an indicator system for the statistical and categorical model of manufacturing industry environmental elements. The first step involves organizing relevant research dimensions associated with the aforementioned theories, compiling sub-category research data under each theoretical dimension, and summarizing the research content related to the above theoretical directions A-E. Subsequently, statistical techniques are employed to consolidate similar factors within these theoretical directions A-E. This consolidation is further refined and categorized into cluster groups to establish the research dimensions and logical framework for the model of manufacturing industry resource endowment and international competitiveness. Furthermore, the research classifies and summarizes the theoretical research dimensions of the model for manufacturing industry resource endowment and international competitiveness. These dimensions are then aligned with empirical statistical data and compiled into Table 1, which represents the theoretical research dimensions and empirical statistical data items outlined in the design. The effectiveness of the theoretical model is evaluated through empirical data analysis sourced from platforms such as the International Labor Organization (ILO), World Intellectual Property Organization (WIPO), World Bank, Federal Statistical Office of Germany, Labor Statistics Bureau of Japan, and the US Department of Commerce.

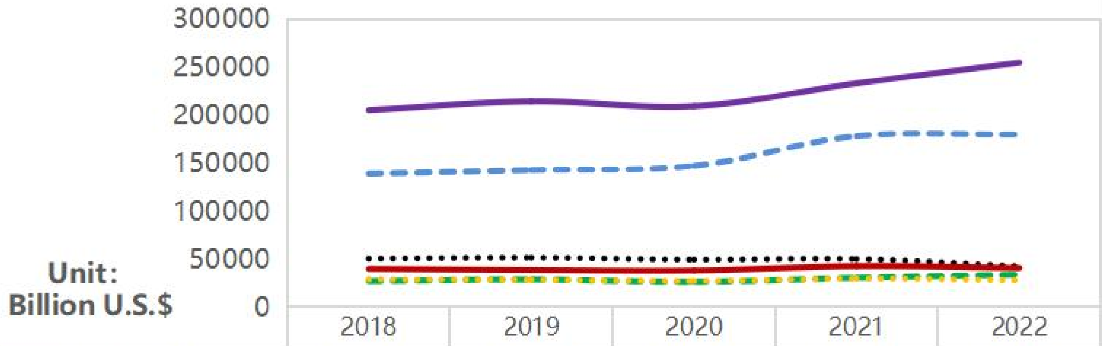
Table 1. Selection and Design of Indices for the Theoretical Model of Manufacturing Industry Resource Endowment and Its International Competitiveness Big Data Model

Index	*International Competitiveness Model (Soft Power): Research Dimensions Based on Theoretical Analysis*	*International Competitiveness Model (Soft Power): Selection of Indices Corresponding to Empirical Research (*Index: A-C*)*	International Competitiveness Model (Hard Power/Rigid Constraints): Variable Design for Index: D Manufacturing Industry Resource Endowment Index
1	Labor skills	A. World Higher Education Power Index	Minimum wage (Level 3 control variable)
2	Labor costs	B. Comprehensive Innovation Index: 2. Human capital and research 6. Knowledge and technology output 7. Creative output	
3	Technological innovation		
4	Policy support (Government)	B. Comprehensive Innovation Index: 1. Institutions	Manufacturing industry output (Level 1 controlled variable)
5	Tax policies		
6	Regulation and governance capacity (Government)		Average GDP growth rate in the past 5 years (Level 1 explanatory variable)
7	Environment and sustainable development	B. Comprehensive Innovation Index: 3. Infrastructure	Plain area (Level 3 control variable)
8	Logistics and infrastructure	C. Logistics Performance Index	
9	Market size and Demand	B. Comprehensive Innovation Index: 4. Market maturity	Labor wage * Population No. (Level 3 control variable)
10	Industry chain relevance	B. Comprehensive Innovation Index: 5. Entrepreneurial maturity	Proportion of manufacturing industry in GDP (Level 3 explanatory variable)

III. RESEARCH HYPOTHESIS AND RESEARCH SUBJECT

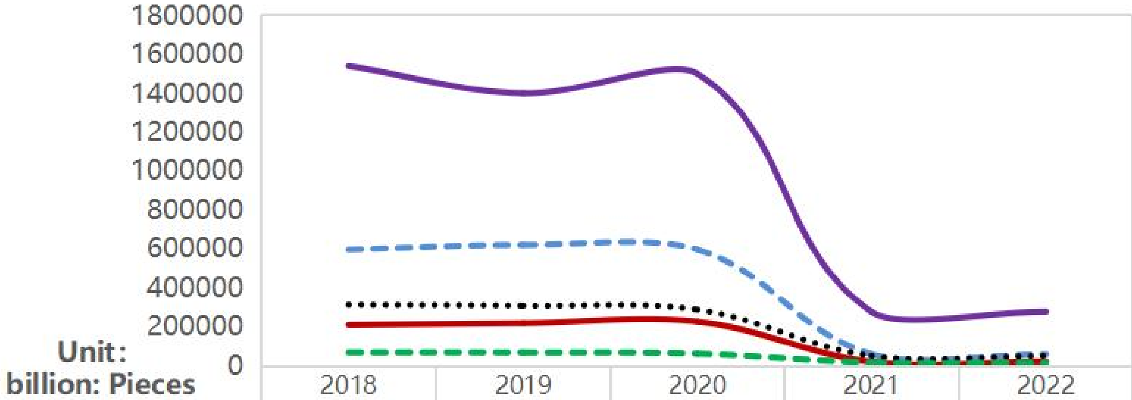
A. Analysis of Model Indicators Based on Empirical Data and Research Hypotheses.

The study surveyed historical data of major manufacturing countries worldwide in the past five years, as illustrated in Figure 1. Taking labor skills, labor costs, technological level, market size and demand, logistics and infrastructure, government policy support, tax policies, and environmental and sustainable development as eight dimensions, they are defined as the core influencing factors for regional manufacturing industry development analysis. Statistical analysis revealed that the world's advanced manufacturing countries demonstrated strong competitiveness in areas such as technological innovation (as shown in Figure 2), labor skills (as shown in Figure 3), market size and demand (as shown in Figure 4), logistics and infrastructure. The study found that the ranking of world manufacturing power countries and the ranking data of the seven dimensions including labor skills, technological level, market size and demand, logistics and infrastructure, government policy support, tax policies, and environmental and sustainable development have a similar sequential relationship. Theoretical research dimension empirical verification was successful, with high-end manufacturing positively correlated factors such as labor costs having a similar sequential relationship with low-end manufacturing negatively correlated factors. The data analysis of the eight dimensions is as follows:



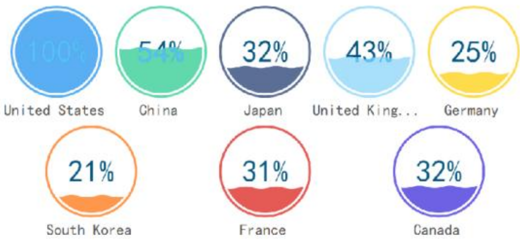
	2018	2019	2020	2021	2022
1 United States	205331	214332	209366	233146	254645
2 China	138949	142799	147227	178135	179928
3 Japan	50409	51488	49300	49992	42288
4 Germany	39744	38611	38061	42599	40722
5 India	27029	28705	26230	30447	33770
5 United Kingdom	28782	28308	27077	29579	27829

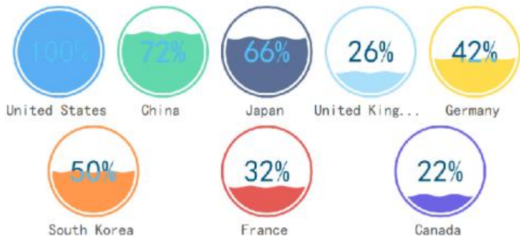
Figure 1: Top Five Countries by GDP Ranking and Total Value (in billion US dollars)
Data Source: International Monetary Fund (IMF)



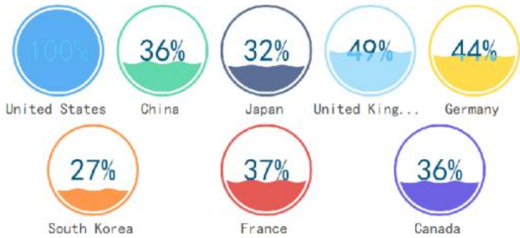
	2018	2019	2020	2021	2022
1 China	1540000	1400000	1500000	277182	278100
2 United States	597141	621453	597172	59403	59056
3 Japan	313567	307969	288472	50275	50345
4 South Korea	209992	218975	226759	20723	22012
5 Germany	67898	67434	62105	17266	17530

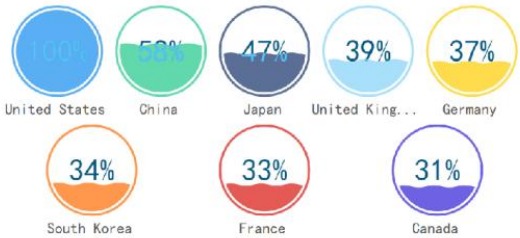
Figure 2: WIPO Patent Application Ranking and Total Number (in pieces)
Data Source: World Intellectual Property Organization (WIPO)





a. World Academic Centrality Index b. World Technological Centrality Index





c. World Talent Centrality Index d. Index of a Powerful Higher Education Country

Figure 3: Index of a Powerful Higher Education Country Sequence

Data Source: China Higher Education Information Research Association

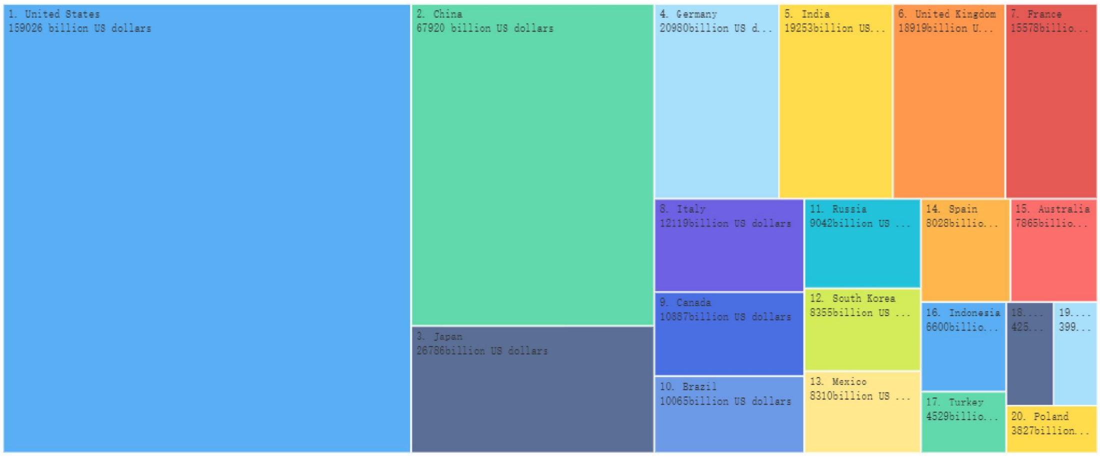


Figure 4: Top 20 Consumer Markets in the World by Expenditure Approach GDP: Total Final Consumption Expenditure by Residents (in billion US dollars)

Data Source: World Bank Database "Households and NPISHs Final Consumption Expenditure" 2021

1) Technological Level (Variable 1: Strong Positive Correlation): As evidenced in Figures 2, data on technology patent applications and their growth rates in major economies including the United States, China, Germany, Japan, South Korea, and India suggests a positive correlation between technological advancement, industrial production, and GDP growth. Notably, countries such as Germany, Japan, and South Korea are recognized for their prowess in manufacturing technology innovation, attributed to substantial investments and strategic initiatives in technology research and high-end manufacturing sectors, underscoring their leadership in technological innovation.

2) Labor Skills (Variable 2: Strong Positive Correlation): On October 14, 2023, the China Higher Education Information Research Association introduced the "Index of a Powerful Higher Education Country," in collaboration with the Evaluation and Research Center of Renmin University of China and the School of Education of Renmin University of China. This groundbreaking index signifies a potential secondary global center for higher education. As evidenced in Figures 3, the index ranking demonstrates a direct relationship with comprehensive national strength. While the United States, a primary global center for higher education, achieves a perfect score of 100 across all indices, China scores 57, 72, and 36 in the indices of world academic centrality, world technological centrality, and world talent centrality respectively. This highlights the urgent need for China to enhance its attractiveness in global talent acquisition and academic research vitality by improving the level of scientific research in higher education, enhancing quality, quantity, and speed, and fostering an academic ecosystem conducive to cultivating high-level scientific and technological talents.

3) Market Size and Demand (Variable 3: Strong Positive Correlation): China's position as one of the world's largest consumer markets, characterized by its vast population and escalating demand, presents a stable market for the manufacturing industry, attracting numerous multinational corporations to establish production facilities within its borders. World Bank data indicates that in 2022, the global retail market was valued at $27.34 trillion, with China's total retail sales of consumer goods reaching ¥44 trillion. The U.S. recorded e-commerce retail sales of $657.3 billion, while European e-commerce retail sales amounted to $456.4 billion, reflecting a growth rate of 7.8%. The European e-commerce market remains strong, with projections indicating retail sales exceeding $500 billion by 2025. Figure 4 illustrates the significant market size and demand of major manufacturing powerhouses worldwide, suggesting a positive correlation between market size and demand with the development and distribution of the manufacturing industry. Wherever Times is specified, Times Roman or Times New Roman may be used. If neither is available on your word processor, please use the font closest in appearance to Times. Avoid using bit-mapped fonts if possible. True-Type 1 or Open Type fonts are preferred. Please embed symbol fonts, as well, for math, etc.

4) Logistics and Infrastructure (Variable 4: Weak positive correlation): In international trade of goods, about 60% of the time is spent on maritime transportation. However, the most significant delays occur when containers are held up at the origin or destination—ports, airports, or intermodal facilities. Policies that target these facilities, such as investing in port efficiency, modernizing customs procedures, and adopting new technologies, can help establish an efficient logistics system that links the supply chain. This ensures a stable supply of raw materials and facilitates product trading for factories. The World Bank's Global Logistics Performance Index (LPI) rates the trade logistics performance of 139 countries globally on a 5-point scale, evaluating them based on customs efficiency, infrastructure quality, international shipments handling, logistics capacity and quality, timeliness, as well as tracking and tracing capabilities. Brunei, Myanmar, and Timor-Leste are excluded from this analysis. Among the top 40 countries/regions globally, Singapore leads the LPI rankings, followed by Finland and Denmark in second and third place respectively. China Hong Kong, China holds the tenth spot, China Taiwan ranks thirteenth, China ranks seventeenth, and the United States fifteenth. Despite ASEAN countries like Singapore, Malaysia, Thailand, and the Philippines ranking high in the LPI in 2022 and 2023, these nations are not the top choices for Chinese corporate investment due to logistical considerations being influential but not the sole determining factor.

5) Government Policy Support (Variable 5: Positive correlation): Analysis of government policies concludes that a more diversified audience targeted by policies across various social strata leads to stronger support and drive for technological advancement. Mobilizing the expertise of a wide population is crucial for sustainable socioeconomic growth. Facilitating broad-based benefits and inclusive participation in industrialization, digitalization, technological advancement, and societal division of labor is essential for unlocking the potential of diverse groups. Evaluating policy progress should adhere to this principle. Scholar Dani Rodrik highlighted in his work "Economic Rules: The Development of Nations, Markets, and Globalization" the pivotal role of government backing and policy direction in manufacturing development. For instance, China's "Made in China 2025" strategy aims to boost manufacturing technology and innovation capabilities, attract investments, and foster new industries. Analysis of high-end manufacturing policy support in the last five years in the US, China, Germany, Japan, India, and the UK yields the following insights: a) China and the US prioritize strategic elevation of policy; b) Economically, China, Japan, and India offer tax incentives for high-end manufacturing, while the US mainly provides loans and subsidies. Germany and the UK allocate funds for innovating emerging industry technologies. c) Operationally, Germany offers practical policies conducive to industrial growth, supporting human resource training, technological funding, and enhancing supply chain competitiveness through digital integration. d) Regarding technology diffusion, China encourages mass participation in high-end manufacturing development without tiered barriers. China's promotion of indigenous innovation in intellectual property aligns with its leading position in global technical patent applications, benefitting numerous Chinese firms in the international high-end market. Japan focuses on R&D promotion and academia-industry collaboration, resonating with chaebol interests and fostering precise innovation. India concentrates on attracting foreign investment and R&D to suit developing nations' needs, noting the two-tier disparity in Indian human resource quality.

6) Tax Policy (Variable 6: Positive Correlation): Based on the World Bank's "Doing Business Report 2020," countries like Ireland, Singapore, and Hong Kong have successfully attracted foreign manufacturing companies by implementing low tax rates and preferential policies. This has boosted the competitiveness of their manufacturing sectors, notably in the case of Singapore. Leading manufacturing nations globally have introduced tax deduction and exemption policies to stimulate technological innovation in research and development by enterprises. Some examples include: ***United States:*** *a) Research and Development Tax Credit: Companies can receive tax credits for expenditures in R&D. b) Investment Tax Credits: Incentives such as reduced corporate income tax rates and tax breaks for specific investments like bonus depreciation. c) Patent Box Regime: Tax benefits for companies holding relevant patents.* ***China:*** *a) Tax Reduction and Fee Cuts: Measures like reducing corporate income tax rates, VAT exemptions, and comprehensive VAT reform to alleviate the burden on businesses. b) Pre-tax Deduction for R&D Expenses: Encouraging higher investments in technology R&D by allowing pre-tax deductions for certain R&D expenses. c) Tax Incentives for High-tech Enterprises: High-tech firms can benefit from preferential corporate income tax rates and other tax policies.*

7) Environmental and Sustainable Development (Variable 7: Positive Correlation): Scholars Michael E. Porter and Mark R. Kramer emphasized in their work "Creating Shared Value" the importance for companies to prioritize sustainable production and green manufacturing to address societal and environmental needs. Major manufacturing nations in recent years have focused on enhancing environmental quality and promoting green renewable energy. They have implemented various incentives and restrictions related to clean energy promotion, pollution control, energy conservation, emission reduction, air quality improvement, and carbon emission control. For instance: ***United States:*** *a) Clean Power Plan: Aiming to reduce greenhouse gas emissions, enhance air quality, foster renewable energy development, and provide cleaner energy options. b) Regional Greenhouse Gas Initiative: Targeting carbon emission reductions through a market mechanism that limits greenhouse gas emissions and incentivizes emission reduction measures. c) Goals to increase the proportion of renewable energy in electricity generation. d) Measures to restrict emissions from coal-fired power plants.* ***China:*** *a) Energy Conservation and Emission Reduction Targets in the "13th Five-Year Plan": Geared towards sustainable economic development, environmental quality improvement, energy consumption reduction, and pollutant emission control. b) Development of new energy industries and promotion of renewable energy to diversify the energy mix, reduce dependence on conventional sources, and boost green energy growth. c) Environmental tax reform to impose taxes on emissions and pollutants, guiding entities and individuals to cut emissions and encouraging the application of environmental protection technologies. d) Addressing urban air pollution to bolster air quality, lessen hazy days, and enhance people's well-being.* ***India:*** *a) Renewable Energy Development Objectives involving solar and wind energy to advance the renewable energy sector, decrease reliance on traditional energy sources, cut greenhouse gas emissions, and enhance air quality. b) Phasing out outdated, high-pollution factories. c) Promotion of energy efficiency practices to improve energy utilization, cut energy wastage, and meet sustainable development objectives. d) Increasing awareness of environmental protection and resource management to boost environmental awareness, safeguard natural resources, minimize environmental pollution, etc.*

8) Labor Cost Analysis from an Academic Perspective (Variable 8: Strong Positive Correlation): Labor cost is a crucial factor influencing foreign investment in manufacturing industries, particularly in East Asia and Southeast Asia, including countries like China, Indonesia, and Bangladesh. These nations have emerged as attractive destinations for multinational corporations due to their competitive labor costs. According to the International Labour Organization (ILO), China has maintained a relatively stable growth in its average actual hourly wage over the past decade, although it remains comparatively low. In contrast, countries like the United States, Germany, and Japan boast higher average hourly wage levels in their manufacturing sectors. The U.S. Bureau of Labor Statistics reports that the average manufacturing hourly wage in the United States is $28.11, while Germany's stands at € 34.72 (approximately $40.5) and Japan's at 1,865 yen (around $16.8). In urban areas of India, non-agricultural workers earn an average daily wage ranging from 400 to 500 Indian Rupees, which is below $10 per day. Developed manufacturing countries, such as the USA, Germany, Japan, and the UK, set their minimum daily wage at over $100. Analyzing the data further, we observe a trend where high labor cost countries tend to prioritize the development of high-end manufacturing with advanced technology and value-added processes. Conversely, low and medium-end manufacturing activities are often outsourced to neighboring regions with lower labor costs, which serve as significant consumer markets. This phenomenon leads to a basic hypothesis: labor cost is positively correlated with the development of high-end manufacturing while showing a negative correlation with medium to low-end manufacturing.

B. Selection of Research Case Groups

1) Sample selection of economies unsuitable for manufacturing development: While most countries around the world are suitable for developing manufacturing industries, there are exceptions with limited industrial progress or unique circumstances hindering manufacturing growth. These select countries have small populations, limited economic scales, and underdeveloped industrial sectors. Their economies depend mainly on industries such as tourism, services, and agriculture, with little emphasis on manufacturing or only specialized processing activities. In light of these conditions, a comprehensive analysis sample will consist of 10 countries with populations ranking below 2 million and land areas mostly below 6 million square kilometers.

2) Sample selection of economies suitable for developing high-end manufacturing industries: Focusing on countries with populations ranging from 2 million to 5 million globally, this case group selection targets nations with well-developed manufacturing and high-tech industries boasting complete industrial chains. Samples will be drawn from economies where advanced manufacturing sectors play a significant role. For instance, Singapore exemplifies a nation with a robust manufacturing industry, though constrained by limited land and labor resources. Manufacturing contributes approximately 20% to its GDP, emphasizing high value-added and high-tech sectors.

3) Economies suitable for developing mid to low-end manufacturing industries: It can be identified by selecting countries with underdeveloped manufacturing sectors, large populations exceeding tens of millions, and land areas larger than 1,000 square kilometers as case samples. For instance, Paraguay, Kenya, Croatia, and Cuba have relatively weak industrial bases, relying more on sectors such as agriculture, services, and tourism. Brunei's manufacturing industry, primarily dependent on petroleum and gas, is relatively underdeveloped. Timor-Leste and Laos have small manufacturing sectors with limited contributions to GDP, facing challenges in infrastructure and technology. Cambodia, on the other hand, has seen rapid growth in its manufacturing industry in recent years, particularly in textile and garment production, playing a significant role in its economy.

4）Economies suitable for developing comprehensive manufacturing industries: It can be identified by selecting countries with massive populations exceeding billions and land areas larger than 100,000 square kilometers, or those with the potential to become superpowers as case samples. These countries are well-suited for developing diverse manufacturing sectors, including high-end, middle-end, and low-end manufacturing, utilizing their abundant resources (human, financial, material, and market) and global economic influence within the global supply chain system. Referred to as comprehensive manufacturing chain economies or comprehensive manufacturing economies, these countries rank in the top ten for factors such as labor cost, population, land area, labor skills, technological levels, market size, demand, transportation, and infrastructure.

IV. Analysis of Variables and Model Design

A. Design of Model for Manufacturing Industry Resource Endowment Index Scoring

We adopt the five-level scoring method of Likert scale (1-5 points), where the scores from high to low represent fully agree, mostly agree, neutral, mostly disagree, and completely disagree respectively. By combining detailed scale design with the statistical calculation of variables in Table 2's four groups of models for manufacturing industry resource development index, the index weights and scoring interval distribution of *Manufacturing Industry Resource Endowment Index (MIREI)* are presented in Table 3. If the value of an index item falls outside the scoring interval, it is scored as 0.

Let "Manufacturing Industry Resource Endowment Index" be denoted as Y_ω, $Y_\omega = y_\alpha + y_\beta + y_\gamma + y_\delta$, where $y_\alpha = -1 * \left[f_{1(A_l)} + f_{1(L_n)} + f_{1(L_w)} + F_{1(G_r)} \right]$, $y_\beta = f_{2(A_l)} + f_{2(L_n)} + f_{2(L_w)} + f_{2(G_r)}$, $y_\gamma = f_{3(A_l)} + f_{3(L_n)} + f_{3(L_w)} + f_{3(G_r)}$, $y_\delta = f_{4(A_l)} + f_{4(L_n)} + f_{4(L_w)} + f_{4(G_r)}$. The variables' definitions and their symbol explanations are shown in Table 2 for the aforementioned 5 equations. By referring to Likert scale and its weights in Table 3, statistical analysis and calculations are conducted on the variable indicators of each sample economy in Table 2.

Based on the secondary control variables and secondary explanatory variable indicators in Table 2, calculate the corresponding values for each case group economy/country in 2022. Refer to the equations in Table3, input the values accordingly, and calculate the values of the primary control variables and secondary controlled variables - Manufacturing Industry Resource Endowment Index for each case group economy/country. The algorithm is as follows: Firstly, calculate the values of $f_{1(A_l)}$, $f_{1(L_n)}$, $f_{1(L_w)}$, $f_{1(G_r)}$ sequentially to obtain the Index of Resource Element Constraints on the Development of Medium and Low-end Manufacturing Industries

(y_α) for each target case economy, then proceed to calculate the y_β, y_γ, and y_δ values for each case economy based on y_α. Finally, add up the 4 sets of y_α, y_β, y_γ, and y_δ values to obtain the Manufacturing Industry Resource Endowment Index (Y_ω) value for that economy/country. A higher value of Manufacturing Industry Resource Endowment Index Y_ω indicates that the manufacturing industry development of that economy has more potential, vitality, and balanced and healthy manufacturing resources, demonstrating strong competitiveness or potential and momentum for manufacturing industry development. Conversely, a lower value indicates a gap between the core resource elements for current manufacturing industry development and the potential for international competitiveness, making it difficult for the manufacturing industry to achieve strong and sustainable development or having limited development space. According to empirical case statistical analysis data, Y_ω values between 6-10 are considered healthy, 8-10 are considered vibrant, and below 3 are considered weak.

Table 2. (Secondary, Tertiary) Variable Definitions and Variable Logic Relationship Models

Types of Variables	Variables/Indicators		Symbol Representation	Calculation Equation
Controlled Variables	Primary Control Variables & Secondary Controlled Variables	Manufacturing Industry Resource Endowment Index	Y_ω	$Y_\omega = y_\alpha + y_\beta + y_\gamma + y_\delta = \sum_1^4 f_{n(Al)} + \sum_1^4 f_{n(Ln)} + \sum_1^4 f_{n(Lw)} + \sum_1^4 f_{n(Gr)}$
Control Variables	Secondary Control Variables & Tertiary Controlled Variables	Index of Resource Element Constraints on the Development of Medium and Low-end	y_α	$y_\alpha = -1*[f_{1(Al)} + f_{1(Ln)} + f_{1(Lw)} + F_{1(Gr)}]$
		Manufacturing Industries Competitiveness Index of Resource Elements for Medium and Low-end Manufacturing Industries	y_β	$y_\alpha = f_{2(Al)} + f_{2(Ln)} + f_{2(Lw)} + f_{2(Gr)}$
		Pressure and Driving Factors Index of Resources for High-end Manufacturing Industries	y_γ	$y_\alpha = f_{3(Al)} + f_{3(Ln)} + f_{3(Lw)} + f_{3(Gr)}$
		Competitiveness and Driving Factors Index of the Entire Manufacturing Industry Chain at High, Medium, and Low Ends	y_δ	$y_\alpha = f_{4(Al)} + f_{4(Ln)} + f_{4(Lw)} + f_{4(Gr)}$
	Tertiary Control Variables	Plain Area	A_l	$\sum_1^4 f_{n(Al)} = -1*[f_{1(Al)} + f_{2(Al)} + f_{3(Al)} + f_{4(Al)}]$
		Population Size	L_n	$\sum_1^4 f_{n(Ln)} = f_{1(Ln)} + f_{2(Ln)} + f_{3(Ln)} + f_{4(Ln)}$
		Labor Force Wages	L_w	$\sum_1^4 f_{n(Lw)} = f_{1(Lw)} + f_{2(Lw)} + f_{3(Lw)} + f_{4(Lw)}$
Explanatory Variables	Tertiary Explanatory Variables	Share of Manufacturing Industry in GDP	G_r	$\sum_1^4 f_{n(Gr)} = f_{1(Gr)} + f_{2(Gr)} + f_{3(Gr)} + f_{4(Gr)}$

An example illustrating the calculation of the *Index of Resource Element Constraints on the Development of Medium and Low-end Manufacturing Industries* (y_α) is provided below following the structured language of the y_α algorithm, with reference to Table 3 scale and Table 2 equation.

First, calculate $f_{1(Al)}$ according to Table 2. : IF 60km^2 < A_l ≤100km^2 ,THEN $f_{1(Al)}$ =0.25*1; IF 30km^2 < A_l ≤60km^2 ,THEN $f_{1(Al)}$ =0.25*2; IF 10km^2 < A_l ≤30km^2 ,THEN $f_{1(Al)}$ =0.25*3; IF 5km^2 < A_l ≤10km^2 ,THEN $f_{1(Al)}$ =0.25*4; IF A_l ≤5km^2, THEN $f_{1(Al)}$ =0.25*5.

Continue to calculate $f_{1(Ln)}$ based on Table 3. : IF 1 million< L_n ≤1.5 million ,THEN $f_{1(Ln)}$ =0.25*1; IF 0.5 million< L_n ≤1million, THEN $f_{1(Ln)}$ =0.25*2; IF 0.1 million< L_n ≤ 0.5 million, THEN $f_{1(Ln)}$ =0.25*3; IF 0.01million< L_n ≤ 0.1 million, THEN $f_{1(Ln)}$ =0.25*4; IF L_n ≤ 0.01million, THEN $f_{1(Ln)}$ =0.25*5.

Then calculate $f_{1(Lw)}$: IF L_w < 500$, THEN $f_{1(Lw)}$ =0.25*1; IF 500$ ≦ L_w < 1000$, THEN $f_{1(Lw)}$ =0.25*2; IF 1000$ ≦ L_w < 1500$, THEN $f_{1(Lw)}$ =0.25*3; IF1500$ ≦ L_w < 2500$, THEN $f_{1(Lw)}$ =0.25*4; IF 2500$≦ L_w , THEN $f_{1(Lw)}$ =0.25*4.

And then calculate $f_{1(Gr)}$, IF 4% < G_r ≦ 5%, THEN $f_{1(Gr)}$ =0.25*1; IF 3% < G_r ≦ 4%, THEN $f_{1(Gr)}$ =0.25*2; IF 2%< G_r ≦3%,THEN $f_{1(Gr)}$ =0.25*3; IF 2%< G_r ≦1%, THEN $f_{1(Gr)}$ =0.25*4; IF G_r ≦ 1%,THEN $f_{1(Gr)}$ =0.25*5.

Table 3. Manufacturing Industry Resource Endowment Index Scoring Table / Sub-item Scoring Table for Rigid Constraints of Manufacturing Development

Assigning	Likert Scale for Manufacturing Industry Resource Endowment Index	Completely Agree	Mostly Agree	Neutral	Mostly Disagree	Completely Disagree	Weight	Note ★ Indicates Classifying Determinant Index	
		5	4	3	2	1		Interval Values	Core Elements
-1	The index of constraints on resource endowment for the development of mid-to-low-end manufacturing industry y_α=-1 *[f1(Al)+f1(Ln)+f1(Lw)+f1(Gr)]	2500$≦Min Monthly Salary PPP$	1500$≦Min Monthly Salary PPP$＜2500$	1000$≦Min Monthly Salary PPP$＜1500$	500$≦Min Monthly Salary PPP$＜1000$	Min Monthly Salary PPP$＜500$	**0.25**	There is no significant entry threshold, but the higher, the less suitable. **f1(Lw)**	Minimum wage
		Manufacturing Industry/GDP ≦1%	1%＜Manufacturing Industry/GDP ≦2%	2%＜Manufacturing Industry/GDP ≦3%	3%＜Manufacturing Industry/GDP ≦4%	4%＜Manufacturing Industry/GDP ≦5%	0.25	Manufacturing Industry/GDP ≦5% f1(Gr)	Manufacturing industry GDP share is extremely low
		Population Scale ≦ 10,000	1＜Population Scale ≦ 0.1million	10＜Population Scale≦ 0.5million	50＜Population Scale≦ 1 million	100＜Population Scale≦ 1.5million	0.25	★Population Scale≦ 1.5million f1(Ln)	Population size bottleneck
		Plain Area ≦5km²	5km²＜Plain Area ≦10km²	10km²＜Plain Area ≦30km²	30km²＜Plain Area ≦60km²	60km²＜Plain Area ≦100km²	0.25	★Plain Area ≦ 100km² f1(Al)	Comfortable plain area factor
1	The index of competitiveness of resource endowment for the development of mid-to-low-end manufacturing industry y_β=f2(Al)+f2(Ln)+f2(Lw)+f2(Gr)	**Min** Monthly Salary **PPP$＜200$**	**200$≦Min** Monthly Salary **PPP$＜400$**	**400$≦Min** Monthly Salary **PPP$＜600$**	**600$≦Min** Monthly Salary **PPP$＜800$**	**800$≦Min** Monthly Salary **PPP$ ＜1000$**	0.25	**Min** Monthly Salary**PPP$ ＜ 1000$ f2(Lw)**	Minimum wage
		5%＜Manufacturing Industry/GDP≦10%	10%＜Manufacturing Industry/GDP ≦15%	15%＜Manufacturing Industry/GDP ≦ 20%	20%＜Manufacturing Industry/GDP ≦25%	25%＜Manufacturing Industry/GDP	0.25	5%＜Manufacturing Industry/GDP f2(Gr)	Manufacturing Industry/GDP
		1 billion ＜ Population Scale	**0.5 billion＜ Population Scale≦1 billion**	**0.2 billion＜ Population Scale ≦ 0.5 billion**	**0.1 billion＜ Population Scale≦ 0.2 billion**	**150 million＜ Population Scale≦0.1 billion**	0.25	**★150 million ＜Population Scale f2(Ln)**	Population size can increase
		0.1 million km²＜ Plain Area	5000km²≦ Plain Area ＜ 0.1 million km²	2000km²≦Plain Area ＜5000km²	600km²≦Plain Area ＜ 2000km²	100km²＜Plain Area ≦600km²	0.25	★100km²＜ Plain Area f2(Al）	Plain area
1	The index of pressure and driving factors for high-end manufacturing industry resources y_γ=f3(Al)+f3(Ln)+f3(Lw)+f3(Gr)	**2500$≦**Min Monthly Salary **PPP$**	**2000$≦**Min Monthly Salary **PPP$＜2500$**	**1500$≦**Min Monthly Salary **PPP$＜2000$**	**1000$≦**Min Monthly Salary **PPP$＜1500$**	**500$≦**Min Monthly Salary **PPP$＜1000$**	0.25	**500$≦**Min Monthly Salary **PPP$ f3(Lw)**	Minimum wage
		Manufacturing Industry/GDP ≦5%	5%＜Manufacturing Industry/GDP ≦10%	10%＜Manufacturing Industry/GDP≦ 15%	15%＜Manufacturing Industry/GDP ≦20%	20%＜Manufacturing Industry/GDP ≦25%	0.25	Manufacturing Industry/GDP ≦25% f3(Gr)	Core element resource bottleneck value of manufacturing industry GDP share
		Population Scale≦1 million	1 million ＜ Population Scale ≦10 million	10 million＜ Population Scale ≦50 million	50 million＜ Population Scale≦100 million	100 million＜ Population Scale ≦300 million	0.25	**There are no significant constraints, but the lower the f3(Ln), the stronger the bottleneck on the share of manufacturing industry GDP.)**	Population Scale
		Plain Area≦600km²	600km²＜Plain Area ≦ 2000km²	2000km²＜Plain Area ≦5000km²	5000km²＜ Plain Area ≦ 0.1million km²	0.1million km² ＜Plain Area	0.25	**There are no significant constraints, but the lower the f3(Al), the stronger the bottleneck on the share of manufacturing industry GDP.**	Plain Area
1	**The index of competition and driving forces for the entire manufacturing industry supply chain of high, middle, and low-ends y_δ=f4(Al)+f4(Ln)+f4(Lw)+f4(Gr)**	**400$≦Min Monthly Salary PPP$＜600$**	**200$≦**Min Monthly Salary **PPP$＜400$**	**600$≦**Min Monthly Salary **PPP$＜800$**	Min Monthly Salary **PPP$＜200$**	**800$≦**Min Monthly Salary **PPP$ ＜1000$**	0.25	**Min Monthly Salary PPP$ ＜ 1000$ f4(Lw)**	Minimum wage
		30%＜Manufacturing Industry/GDP	25%＜Manufacturing Industry/GDP ≦30%	20%＜Manufacturing Industry/GDP≦ 25%	15%＜Manufacturing Industry/GDP ≦20%	10%＜Manufacturing Industry/GDP ≦15%	0.25	10%＜Manufacturing Industry/GDP f4(Gr)	Manufacturing Industry/GDP
		300 million＜ Population Scale	250 million＜ Population Scale ≦300 million	200 million＜人 Population Scale ≦250 million	150 million＜ Population Scale≦200 million	100 million＜ Population Scale≦150 million	0.25	100 million＜ Population Scale f4(Ln)	Population Scale
		300 million km²≦ Plain Area	200 million km²＜Plain Area≦ 300million km²	1million km²＜ Plain Area≦200 million km²	0.1 million km² ≦＜Plain Area ≦1million km²	0.05 million km²＜Plain Area≦0.1 million km²	0.25	0.05 million km²＜Plain Area f4(Al）	Plain Area

B. Variable Analysis

1) Control Variables & Secondary Controlled Variables Y_{ω} : Manufacturing resource endowment index; Secondary control variables & Tertiary controlled variables y_{α} , y_{β} , y_{γ} , y_{δ} . Based on the theoretical research findings of the core indicators of manufacturing resource elements in Table 1, and the empirical data analysis of the case group, comparing the differences in resource endowments of manufacturing industries in different economies, combining historical data of typical world manufacturing economies, categorizing the value ranges of index elements, dividing the development index and current evaluation value range of manufacturing resource elements into four categories, corresponding to values such as $f_{1(A_l)}$, $f_{1(L_n)}$, $f_{1(L_w)}$, $f_{1(G_r)}$. These four indices are then weighted as a single indicator data - Manufacturing Resource Endowment Index Y_{ω} Value. According to the Model in Table 2 and the Algorithm in Table 2, scoring and analyzing the manufacturing economic index of each case economy/country by Sample data, the results are as follows:

Constraint index of resource elements not conducive to the development of middle and low-end manufacturing economies: Value range: -5~0. A value of -5 indicates an extreme disadvantage for developing the manufacturing economy, with the economy's score ranging from -5 to -2, indicating that its resource elements are unsuitable for developing middle and low-end manufacturing, -2 to -1 indicates a lack of resource competitive advantage in developing middle and low-end manufacturing, and -1 to 0.25 represents suitability for developing middle and low-end manufacturing. The value of -0.25 indicates that the current resource elements of the economy have a global competitive advantage in developing middle and low-end manufacturing. For example, Discipleship (Vatican City) with a score of -5, has a population of less than 1000km^2 , limited area, and an average monthly income exceeding \$3000, mainly comprising religious practitioners, which is unsuitable for developing middle and low-end manufacturing. Whereas, China and India both have values of -0.25, indicating a resource advantage in developing middle and low-end manufacturing. Germany and France have values of -1, the United States -0.75, indicating that these countries have a disadvantage in resource element price competitiveness compared to China and India in developing middle and low-end manufacturing. Since the middle and low-end manufacturing market is sensitive to price effects, economies with comprehensive scores between -5 and -0.5 all face varying degrees of constraints in developing middle and low-end manufacturing solely relying on domestic resources, and the lower the score, the more unfavorable it is. Economies with scores in the -5 to -2 range should consider shifting their comprehensive national policies towards the development and market layout of high-end manufacturing.

a) Development of Mid to Low-End Manufacturing Industry Resource Competitiveness Index for Emerging Economies: Value range: 0 to 5. The closer the value is to 5, the more suitable the current resource elements of the economy are for the development of mid to low-end manufacturing industry, and they have competitive advantages in the market. A value between 5 and 3.75 indicates that the current resource elements of the economy have significant price competitiveness in the development of mid to low-end manufacturing industry. The higher the score, the more advantageous it is in terms of resource elements and international market competitiveness for mid to low-end manufacturing industry, and policies should timely promote the rapid development of mid to high-end manufacturing industries. A value range of 3.5 to 1.5 indicates that the economy has the resource elements for developing mid to low-end manufacturing industries, but lacks competitive advantage in terms of price. A value between 1 and 0 represents restrictions on the resource elements for developing mid to low-end manufacturing industries, lacking development resources. A value of 0 indicates unsuitability for developing mid to low-end manufacturing industries, mainly due to limited resources such as population and plain area. For example, countries like India, Brazil, and Bangladesh, which rank high in terms of population and plain area, all have a score of 4.5. These countries have a minimum wage lower than \$200 and a manufacturing sector accounting for less than 20% of GDP, indicating that their domestic markets are not yet saturated and international markets provide labor cost advantages for mid to low-end manufacturing industries, facilitating their development. The United States with 3.5, the UK with 3.5, Russia with 3.75, and China with 3.75 indicate that the latter have more market competitiveness in mid to low-end manufacturing sectors compared to the former. However, a value of 3.75 also suggests that there is overcapacity in the domestic market for mid to low-end manufacturing industry among these economies. If excess production capacity cannot be distributed globally through international trade to developed or underdeveloped regions, domestic markets are approaching saturation and continued vigorous development of mid to low-end manufacturing industries may not be appropriate. Liechtenstein has a value of 0, with a minimum wage exceeding $2500, extremely limited population and area, and lacks the resource elements and market competitiveness for developing mid to low-end manufacturing industries relying on its own resources.

b) Index of Resource Pressure and Driving Forces for Developing High-End Manufacturing Industry in Economies, with a value range of 0 to 5. A value of 5 represents that the resource elements of the economy are only suitable for developing high-end manufacturing industries, and the higher the value, the more urgent the resource pressure for developing high-end manufacturing industries, as failure to successfully capture international market share in high-end manufacturing will lead to the decline or exit from market competition of the economy's manufacturing industry. A value between 5 and 3.5 signifies that the current resource endowments of the economy urgently need to develop high-end manufacturing industries, as the price competitiveness of resource elements for mid to low-end manufacturing and saturation of the domestic market hinder this. For example, Liechtenstein with a score of 5 and Monaco with 4.75 have very limited population and area, but with higher comprehensive labor quality and wages, focusing on technology-oriented high-end manufacturing outputs; Singapore with a score of 3.75 has very limited territory and population factors relative to large manufacturing countries, also possessing characteristics of high-quality human resources for high-end manufacturing. The above-mentioned countries are constrained by resource elements and the proportion of manufacturing industry making continuous growth difficult, with resource constraints for developing mid to low-end manufacturing industries and a comprehensive national strategy favoring the development of high-end manufacturing industries as the most optimal choice. Economies with scores between 3 and 1.5 currently hold a dominant position in the international high-end manufacturing market, with technological monopolies, talent, and market advantages. Their mid to low-end manufacturing industries also have certain market share and room for development, with moderate pressure on resource endowments for developing high-end manufacturing industries, such as the United States, Germany, the United Kingdom, and France scoring at 1.75, 2, 3, 2.75 respectively. They possess a resource foundation and domestic market for developing global manufacturing supply chain systems encompassing high, medium, and low-end sectors. A value between 1.5 and 0 indicates insufficient global market competitiveness for high-end manufacturing industries, significant technological, talent, and market barriers in developing high-end manufacturing, while a value between 1 and 0 suggests varying degrees of overcapacity in the domestic manufacturing industry of the economy, posing greater obstacles to high-end manufacturing development, such as China and Russia with a score of only 0.5.

c) The Resource Competitiveness and Motivation Index of the full manufacturing industry value chain in economic development ranges from 0 to 5. A value of 5 represents that the resource elements of the economy are in a suitable stage for the development of the full manufacturing industry value chain at all levels. The higher the value, the stronger the urgency caused by the resource pressure of the development of the full manufacturing industry value chain at all levels. If the international marketization process of the medium, high, and low-end manufacturing industry cannot be stimulated, the economy will face a period of sustainable development or gradual decline. For example, Japan and South Korea, relying on their rapid development of manufacturing industries in the 1970s and 1980s, become leaders in the Asian economy and occupy important roles in the global manufacturing industry market. However, they missed out on the dividend period of their own manufacturing development due to obstacles in the international supply chain of the full manufacturing industry. They subsequently faced international price competition from emerging medium and low-end manufacturing industries, leading to a decline in their international market competitiveness at all levels of manufacturing industry and a slowdown or stagnation in economic development. Therefore, economies with values ranging from 5 to 3.5 need to rely on their strong resource endowments and manufacturing dividend periods. On the one hand, they need to stabilize domestic demand, absorb and transform excess medium and low-end manufacturing capacity. On the other hand, they need to actively expand overseas trade in all levels of manufacturing industries, rely on the current manufacturing scale economy dividend period generated by the international market share and competitiveness of medium and low-end manufacturing industries, make efforts to develop and enter the high-end manufacturing market, and attach importance to comprehensive domestic industrial chain layout. They should match domestic labor force and market supply-demand stratification development, reasonably regulate and allocate the proportion of domestic medium, high, and low-end manufacturing industries and resources to meet the scale demand of differentiated markets unique to populous countries. Because for a super economy with a labor force of over a billion and a certain manufacturing volume, there must be a hierarchical and quantitative division of labor productivity and purchasing power. Macro control can reasonably control the hierarchical level and quantity of labor force stratification, target the supply and demand of medium, high, and low-end manufacturing industries in different regions, combine the characteristics of resource endowments in different regions, centralize and distribute resources, strengthen the resource cohesion and core competitiveness of specific markets, give play to the gradient competitive price advantage of the resource elements of the economy, and meet the development needs of labor force markets and product markets at different levels. At the same time, social resources should be redistributed to avoid the intensification of social contradictions and population decline caused by the widening gap between the rich and the poor. Economies with scores ranging from 3 to 2 generally have certain resource advantages and belong to emerging economies in the later stage. The former should focus on catching up with economies in this score range in international competition, especially in the field of medium and low-end manufacturing. Economies with scores ranging from 1.5 to 0 lack sufficient resources for the development of the full manufacturing industry value chain at all levels, have limited population pressure, and do not have enough labor resources available for hierarchical development, or other factors such as land are restricted. The optimal strategy is to combine the characteristics of domestic human resources, focus on the development of a certain level, such as high-end manufacturing or other levels of manufacturing. For example, China has a score of 4.75, India has a score of 4, Russia has a score of 3.5, indicating that they are in the manufacturing dividend period. The higher the value, the closer to the peak of the dividend period. Therefore, it is necessary to pay full attention and re-plan in all dimensions to promote the development of segmented domestic markets, guide the rational positioning of the medium, high, and low-end manufacturing industries in the international manufacturing market, and compete with differentiation and coherence. Thailand and the Philippines both have scores of 2.5, indicating that these countries are newly favored emerging economies in the international manufacturing market. Liechtenstein has a score of 0, indicating that these sparsely populated countries have values close to 0 and generally aim to develop the high-end manufacturing market as their strategic position.

Based on historical data on economic activities from various economies, referring to the Likert scale in Table 3, a score is assigned to calculate the global manufacturing resource endowment index. This value is used as the controlled scalar for regression equation data analysis to obtain the model of manufacturing resource endowment and international competitiveness.

2) Three level control variables: plain area, population size, labor wage. According to the analysis of major advanced manufacturing economies worldwide, the policies and tax incentives encouraging advanced manufacturing industries in various countries exhibit mutual reference-ability without significant differences, and are currently not considered as rigid environmental factors distinguishing whether an economy is ready to develop into a full manufacturing industry supply chain. Environmental and sustainable development factors are universally emphasized and valued by major developed manufacturing countries, with insignificant differences. In regions where manufacturing is underdeveloped, due to the small scale of the industry and its limited environmental impact, environmental factors have not yet become significant influences. Therefore, they are collectively considered as non-rigid determining factors for distinguishing whether an economy is ready to develop into a full manufacturing industry supply chain. Labor skills, technological level, and labor cost can be reflected through labor cost, where high-skilled laborers are paid more, and companies with high technological levels generally offer better wages, hence labor wage can serve as a common reflection factor for these three indicators. Market demand and size are positively correlated with local population size and labor wage, therefore market demand and size indicators can be replaced by population size and labor wage indicators. Plain areas suitable for human settlement activities exclude deserts, regions with temperatures constantly above 40 degrees Celsius, and regions with extremely cold temperatures below -10 degrees Celsius. In this text, plain area, representing the physical space for the development of manufacturing industries, is beneficial for population concentration, establishment of manufacturing plant areas, logistics, etc., and has a significant association with the types of manufacturing industry development in major manufacturing countries, serving as a significant influencing factor for distinguishing the manufacturing industry resource endowment index, as shown in Table 4.

3) Three level explanatory variable: Share of manufacturing GDP. The share of manufacturing GDP represents the economic space for the development of manufacturing industries within a country or economic entity. If the share of manufacturing GDP is less than 5%, it indicates that the country's manufacturing industry is in its infancy stage or less suitable for developing medium to low-end scaled manufacturing due to a relatively small population, or is mainly focused on high-end technological industries, suggesting that the demand for manufacturing in the country is yet to be fully developed, relying mainly on imports for medium to low-end manufacturing. However, as the share of manufacturing GDP continues to increase, a country's manufacturing demand is filled by its own supply capacity, gradually entering the stage of excess production capacity. For instance, in developing countries with a share of manufacturing GDP exceeding 25%, although their scale is large, they often focus on medium to low-end manufacturing, resulting in lower unit output value compared to high-end manufacturing, leading to excess production capacity in medium to low-end manufacturing. For countries abundant in population and labor resources with vast territories, it is advisable to timely transition to the strategic stage of simultaneous development of high-end and medium to low-end manufacturing, enabling the global proportion of manufacturing to steadily grow, and allowing medium to low-end manufacturing to shift to regions with moderate development, effectively supporting their high-end manufacturing throughout the entire industry chain, and configuring the global industry chain to reduce the share of domestic manufacturing in GDP to a comfortable level of 20%-30%. Finally, for countries with limited labor and plain resources, they should attempt to transition to the strategic stage of high-end technological industries in manufacturing and international trade and distribution service centers, maintaining the share of manufacturing at a comfortable level of 10%-20%.

Table 4. (Primary) Variable Definition.

Types of Variabl	**Variable**	**Symbol**	**Formula Symbol**	**Variable Description**
Controlled Variable	Manufacturing Gross Domestic Product	MGDP	Mg	Comprehensive strength and efficiency of the manufacturing industry
Control Variable	Manufacturing Industry Resource Endowment Index **(Primary Control Variable & Secondary Controlled Variable)**	MIREI	Y_{ω}	Core competitiveness of manufacturing resource endowment
	Logistics Performance Index	LPI	L_p	Competitiveness of infrastructure and public services
	National Index of Higher Education Power	HEP	H_p	Index of science, technology, talent, and academic centers: nurturing human resources
	Global Innovation Index	GII	G_i	Science and technology innovation transformation: market/business integration/innovation capability
(Third-level) Control Variables	Population Quantity	LN	L_n	Total population * wages ≈ consumption market size
	Minimum Wage for Labor LW	LW	L_w	Labor skills & labor cost competitiveness
	Plain Area	AL	A_l	Geographical space for manufacturing industry development
(Third-level) Explanatory Variables	Manufacturing Industry as a Percentage of GDP	RMG	G_r	Economic space for manufacturing industry development
Explanatory Variables	5-Year Average GDP Growth Rate	AFG	F_g	performance results of comprehensive national strategies such as policies and taxation s
				Performance results of governance capabilities

4) Controlled Variable: Manufacturing Gross Domestic Product (MGDP). Manufacturing GDP can be calculated by multiplying the national gross domestic product (GDP) by the percentage of manufacturing industry in the GDP. It represents the comprehensive strength and potential of a nation's or economy's manufacturing industry development, serving as an expression value of the global manufacturing supply chain division and competition results. The higher the total value, the stronger the global manufacturing comprehensive strength and potential, with a more significant impact on the global manufacturing supply chain.

5) Control Variables: Manufacturing Resource Development Index (competitiveness of manufacturing resource endowment), Logistics Performance Index (ability of infrastructure and public services needed for manufacturing development), National Index of Higher Education Power (index of science, technology, talent, and academic centers, technological influence and talent cultivation ability), and Global Innovation Index (GII) (ability in management, technology transformation, and marketization). The GII is derived from the World Intellectual Property Organization's (WIPO) Global Innovation Index 2023 research report, calculated based on statistical data of human capital, research infrastructure, market complexity, business complexity, knowledge and technology output, and creative output quantity in various developed, developing, and underdeveloped economies. In this study, the index value is the sum of the scores of the above items divided by 100.

6) Explanatory Variable: 5-Year Average GDP Growth Rate. The comprehensive governance capacity, taxation, policies, and other factors adjusted according to the national situation are important explanatory variables, but difficult to quantify as orderly data based on direct information. As ordered growth of comprehensive national power is one of the core results of balanced efforts in comprehensive national strategies and governance capabilities. Therefore, the score of comprehensive national strategies (evaluated based on policies, taxation, and appropriateness to the national situation) and governance capabilities (macroeconomic regulation, social management, and comprehensive governance abilities related to secondary distribution) can temporarily be represented by the 5-year average GDP growth rate.

V. Empirical Analysis

A. Factors Influencing Manufacturing Resource Endowment

The core resource endowment of the manufacturing industry differs from that of other industries. It is not determined by traditional factors such as water, land, mineral resources, or energy. Regions rich in water and land resources are suitable for agricultural and livestock development, while regions abundant in energy and mineral resources tend to focus on mining, energy smelting, and export-related businesses. The core competitive resources influencing manufacturing industry development are illustrated in the Table 5. They mainly include the size, distribution, and concentration of consumer markets, labor skills and cost competitiveness, market opportunities for manufacturing industry characterized by emerging markets or industries where demand exceeds supply, which can be observed and evaluated by the regional share of manufacturing GDP, and the geographical space for manufacturing development. Given that manufacturing industry requires the clustering of industry chains, the optimal choice is vast plain areas with ample water supply, a pleasant climate conducive to transportation and distribution, providing construction land resources for factories, ports, residential areas, and commercial activities. Therefore, the indicators 1-4 in Table 5 can serve as key competitiveness indicators for evaluating the resource endowment of manufacturing industry development in a country or economic entity.

Table 5. Mind-map of Manufacturing Resource Endowment and International Competitiveness Model

Primary Model	Secondary Model	Resource Classification		Variable Explanation	Variable/KPI	Serial No.
Manufacturing International Competitiveness Impact Factor Analysis	Analysis of Factors Influencing Manufacturing Resource Endowment	**Hardware Capability**	Resource Endowment	Geographical Space for Manufacturing Development	Plain Area	1
				Economic Space for Manufacturing Development	Share of Manufacturing in GDP	2
				Consumer Market Size ≈Approximately Population * Salary	Population Quantity	3
				Labor Skill & Labor Cost Competitiveness	Minimum Wage	4
		Software Capability	Service	Infrastructure and Public Service Competitiveness	Logistics Performance Index	5
			Skills	Technology, Talent, and Academic: Human Resource Cultivation	Higher Education Strength Index	6
				Innovation Capability: Market/Business Integration/Innovation	Comprehensive Innovation Index	7
			Management	Overall National Policy Performance Result (e.g., Policies, Taxation)		9
				Performance Result of Governance Capability	**Average GDP Growth Rate in the Past Five Years**	10

1) Correlation Test: Referring to Table 2 and Table 3, the Manufacturing Resource Endowment Index scoring model calculates the Manufacturing Resource Endowment Index Y_ω , using SPASS 27 to conduct correlation analysis on the plain area, share of manufacturing in GDP, population quantity, minimum wage, Y_ω and other values of 40 case economies/countries: Liechtenstein, Monaco, San Marino, Vatican City (State of the Vatican City), Dominica, Timor-Leste, Brunei, Tajikistan, El Salvador, Libya, Estonia, Slovakia, Latvia, Slovenia, Singapore, Laos, Cambodia, Japan, South Korea, Malaysia, Thailand, Philippines, Indonesia, Bolivia, Pakistan, Nepal, Russia, Canada, China, United States, Germany, United Kingdom, France, Australia, Argentina, Colombia, India, Brazil, Bangladesh, Mexico as case country. The controlled variables are significantly correlated with the dependent variables (two-tailed significance <0.001) and explanatory variables (two-tailed significance = 0.002). This indicates that the controlled variables in the model are well able to explain and associate with the dependent and explanatory variables, the model design is effective, and the Manufacturing Resource Endowment Index has comprehensive descriptive value. Apart from the significant correlation between plain area and population quantity, the rest of the dependent and explanatory variables show no significant correlation, indicating them as independent influencing factors.

2) Principal Component Analysis: As shown in Tables 6-8, the KMO value for the principal component analysis of the model's dependent and explanatory variables is 0.546; whereas for the principal component analysis of the model's controlled variables, dependent variables, and explanatory variables, the KMO value further decreases to 0.486, indicating that they are not suitable for principal component analysis. This suggests that the dependent and explanatory variables have their own typical representational value selections, supporting the conclusions of the previous theoretical analysis that the chosen dependent variables are all independent influencing factors. The added value can be observed in three dimensions: human resources (population * minimum wage, representing labor quantity, labor cost, labor skills, etc.), market resources (population * minimum wage * GDP share of manufacturing, representing purchasing power and demand quantity, reflecting the volume of economic space for manufacturing development), and land resources (plain area, representing the physical space volume for manufacturing development), which comprehensively evaluate the influencing factors of manufacturing resource endowment in the economy and assess the hardware capability of comprehensive competitiveness in manufacturing development.

Table 6. Empirical Test Analysis of Variable Correlation in the Manufacturing Resource Endowment Model: Correlation

		Plain area (km^2)	Population (10,000 people) in 2022	Minimum wage in 2022	Manufacturing industry as a percentage of GDP in 2022	Manufacturing industry resource endowment index in 2022
Plain area in square kilometers	Pearson correlation	1	.486**	-.117	.061	.573**
	Significance (two-tailed)		.001	.473	.707	.000
	Number of cases	40	40	40	40	40
Total population (in tens of thousands) in 2022	Pearson correlation	.486**	1	-.259	.279	.509**
	Significance (two-tailed)	.001		.107	.081	.001
	Number of cases	40	40	40	40	40
Minimum wage in 2022	Pearson correlation	-.117	-.259	1	-.168	-.603**
	Significance (two-tailed)	.473	.107		.300	.000
	Number of cases	40	40	40	40	40
Manufacturing industry as a percentage of GDP in 2022	Pearson correlation	.061	.279	-.168	1	.467**
	Significance (two-tailed)	.707	.081	.300		.002
	Number of cases	40	40	40	40	40
Manufacturing industry resource endowment index in 2022	Pearson correlation	.573**	.509**	-.603**	.467**	1
	Significance (two-tailed)	.000	.001	.000	.002	
	Number of cases	40	40	40	40	40
**. The correlation is significant at the 0.01 level (two-tailed).						

Table 7. Empirical Test Analysis of Variable Correlation in the Manufacturing Resource Endowment Model: Descriptive statistics

	mean	Standard deviation	Number of cases analyzed
Plain area in square kilometers	829724.5678	1376177.53044	40
Total population (in tens of thousands) in 2022	13238.8950	30218.70102	40
Minimum wage in 2022	$1,081.6500	$960.38108	40
Manufacturing industry as a percentage of GDP in 2022	14.7450	9.30831	40
Manufacturing industry resource endowment index in 2022	5.4938	2.22924	40

Table 8. Empirical Test Analysis of Variable Correlation in the Manufacturing Resource Endowment Model: KMO and Bartlett's Test

KMO Measure of Sampling Adequacy		.486
Bartlett's Test of Sphericity	Approx.Chi-Square	65.754
	Degrees of Freedom	10
	Significance	.000

B. Factors Affecting the International Competitiveness of the Manufacturing Industry

1) Correlation Analysis. Through SPASS correlation analysis of historical data from 40 countries' cases between 2018 and 2023, as shown in Tables 9-11, four indices are strongly correlated with the total manufacturing output value. The Manufacturing Resource Endowment Index, serving as a semi-constant index (semi-constant meaning that part of the controlled variables are constant factors while others are variables: for example, plain area and population resources which are difficult to undergo significant changes in the short term can be treated as constants, indicating that the endowment of physical space for manufacturing development should not change; whereas variables like minimum wage and GDP share, reflecting economic spatial endowment resources, gradually change over time, indicating changes in economic space endowment for manufacturing development). It shows no significant correlation with the logistics performance index, higher education power index, and comprehensive innovation index, but there is a correlation with the higher education power index due to factors related to labor skills and costs. In conclusion, the "Factors Affecting the International Competitiveness of the Manufacturing Industry Model" established in Table 5 regarding the variable definitions explains the relationships between the variables Y_ω , and the controlled variables Mg have been verified to be more effective than the other three control variables in the same dimension. The Manufacturing Resource Endowment Index is considered the representative index of hardware capability for the factors affecting the international competitiveness of the manufacturing industry. This index, as opposed to the traditional "hardware" representing physical infrastructure, refers to the fundamental constraints on the development of a country's manufacturing industry constituted by resource endowment factors affecting the physical and economic space for manufacturing development over time. On the other hand, the logistics performance index, higher education power index, and comprehensive innovation index represent the soft power of the manufacturing industry in each country: services, skills, management, thereby providing complementary services and basic equipment facilities for economic entities' manufacturing development; providing policies for technical talent and technology research and development, education, and research support systems for human resources; as well as providing administrative/national governance capabilities for good social order and public management services for the country's industrial development.

Table 9. Correlation Empirical Test of the Impact Factors of International Competitiveness in Manufacturing Industry: Descriptive statistics

	mean	Standard deviation	Number of cases analyzed
Manufacturing Industry Resource Endowment Index 2022	5.4938	2.22924	40
Logistics Performance Index for Infrastructure 2023	2.6375	1.43557	40
Higher Education Power Index 2023	17.4000	18.99366	40
Comprehensive Innovation Index 2023	2.1991	1.06879	40
Average GDP Growth Rate for the Past Five Years (2018-2022)	2.4850	3.40637	40
Total Manufacturing Industry Output Value (in hundred billion US dollars) 2022	5.97599762	11.357034813	40

Table 10. Correlation Empirical Test of the Impact Factors of International Competitiveness in Manufacturing Industry: KMO and Bartlett's Test

KMO Measure of Sampling Adequacy		.616
Bartlett's Test of Sphericity	Approx.Chi-Square	89.901
	Degrees of Freedom	15
	Significance	.000

Table 11. Correlation Empirical Test of the Impact Factors of International Competitiveness in Manufacturing Industry: Factor Matrix a

	Factor	
	1	2
Manufacturing Industry Resource Endowment Index 2022	.591	.500
Logistics Performance Index for Infrastructure 2023	.731	-.452
Higher Education Power Index 2023	.823	-.207
Comprehensive Innovation Index 2023	.864	-.374
Average GDP Growth Rate for the Past Five Years (2018-2022)	.420	.491
Total Manufacturing Industry Output Value (in hundred billion US dollars) 2022	.601	.536
Extraction method: Principal Component Analysis.		
a. 2 factors were extracted.		

2) Component Analysis. According to Tables 9-11, the component matrix A given by 6 factors, we can interpret as follows: For the first component (Component 1), the Manufacturing Industry Resource Endowment Index 2022, Infrastructure 2023 Logistics Performance Index, Higher Education Power Index 2023, and Comprehensive Innovation Index 2023 all have high positive loadings, indicating that they have a strong positive correlation with this component. For the second component (Component 2), the GDP growth rate average over the past five years 2018 to 2022 has a high positive loading, indicating a strong positive correlation with this component. In addition, Infrastructure 2023 Logistics Performance Index, Higher Education Power Index 2023, and Comprehensive Innovation Index 2023 have high negative loadings, indicating a strong negative correlation with this component.

Based on these loading values, we can preliminary draw several conclusions: The first component may represent the overall strength and competitiveness of economic development, closely related to manufacturing resources, infrastructure, higher education, and comprehensive innovation capabilities. The proximity of the Logistics Performance Index, the Higher Education Power Index, and the Comprehensive Innovation Index loadings indicates the strength of international competitiveness in the manufacturing industry of various economies, representing both comprehensive development soft power and the current level of economic capacity/strength/index. The second component represents the trend and performance of economic growth, related to GDP growth rate and to some extent, infrastructure, higher education, and comprehensive innovation capabilities. This shows that GDP growth in economies is positively correlated with their manufacturing resource endowment index, constrained by and promoting its hardware resource endowment; the manufacturing resource endowment index, as a potential dependent variable of manufacturing international competitiveness, governs the potential/level/index of the development of international competitiveness of economies.

According to Tables 9-11, the component matrix A given by 4 factors collectively represents the same factor (Component 1), which can be defined as the comprehensive index of international competitiveness in the manufacturing industry. In line with the research hypothesis, modeling analysis can be conducted on the research hypothesis dependent variables.

C. Model of Manufacturing Resource Endowment and International Competitiveness

1) Multivariate Regression Model of Manufacturing Resource Endowment and International Competitiveness Assessment - Linear and Nonlinear Discrete Value Testing. Regression analysis was conducted on the selected 40 country case data according to the theoretical model of this study, and the test data obtained are shown in Tables 12&13. The coefficient of the manufacturing resource endowment index Y_{ω} is 0.354, the coefficient of the Infrastructure 2023 Logistics Performance Index L_p is 0.314, the coefficient of the Higher Education Power Index H_p is 0.314, the coefficient of the Comprehensive Innovation Index G_i is -3.895, * the coefficient of the GDP growth rate average over the past five years F_g is 0.422, and the constant term is -0.407. Therefore, the relationship model between the manufacturing gross domestic product (in hundred billion US dollars) of the manufacturing economy Mg and its manufacturing resource endowment index Y_ω is as follows:

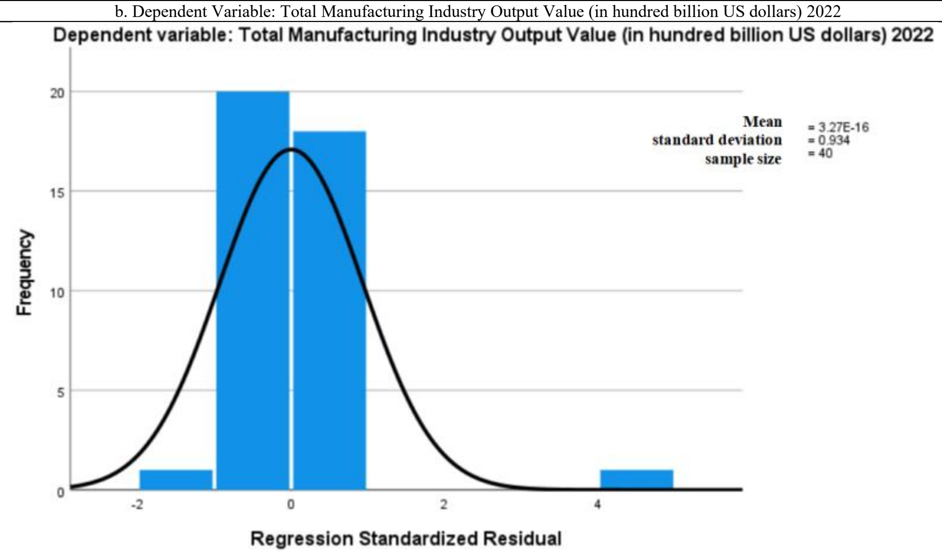
$$Mg_{40} = -0.407 + 0.354 \times Y_\omega + 0.314 \times L_p + 0.314 \times H_p - 3.895 \times G_i + 0.422 \times F_g \quad (1)$$

Table 12. Regression Analysis of Manufacturing Resource Endowment and International Competitiveness Model - 40 Countries: Descriptive statistics

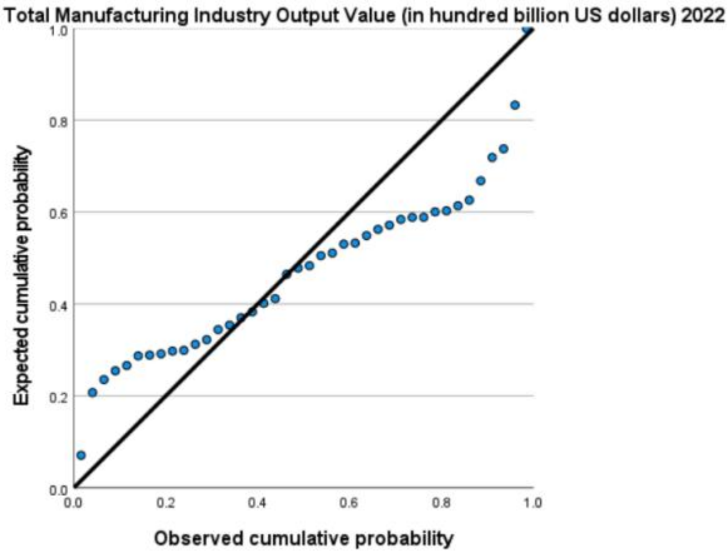
	mean	Standard deviation	Number of cases analyzed
Total Manufacturing Industry Output Value (in hundred billion US dollars) 2022	3.19470362	8.884575761	40
Manufacturing Industry Resource Endowment Index 2022	5.4938	2.22924	40
Logistics Performance Index for Infrastructure 2023	2.6375	1.43557	40
Higher Education Power Index 2023	17.4000	18.99366	40
Comprehensive Innovation Index 2023	2.1991	1.06879	40
Average GDP Growth Rate for the Past Five Years (2018-2022)	2.4850	3.40637	40

Table 13. Regression Analysis of Manufacturing Resource Endowment and International Competitiveness Model - 40 Countries: Model Summary b

Model	R	R Square	Adjusted R Square	Standard Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	1df1	2df2	Significance of F Change	
1	.800[a]	.640	.587	5.707541706	.640	12.100	5	34	.000	2.466
a. Predictors: (Constant), Average GDP Growth Rate for the Past Five Years (2018-2022), Higher Education Power Index 2023, Manufacturing Industry Resource Endowment Index 2022, Logistics Performance Index for Infrastructure 2023, Comprehensive Innovation Index 2023										
b. Dependent Variable: Total Manufacturing Industry Output Value (in hundred billion US dollars) 2022										



a. Histogram



b. Normal P-P Plot of Regression Standardized Residuals

Figure 5: Regression Analysis of Manufacturing Resource Endowment and International Competitiveness Model - 40 Countries.

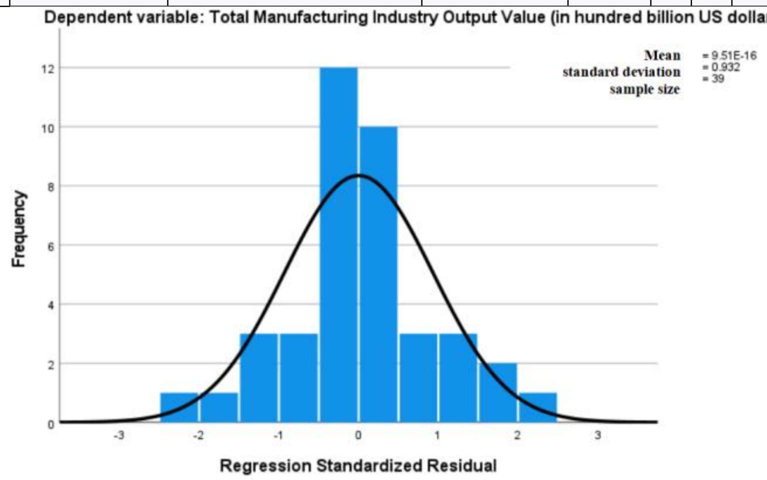
Further optimization of the above model data was conducted by observing the normal distribution P-P plot in Figure 5. The IBM SPSS Statistics 27 software was used to repeatedly test the data set, identifying non-linear distribution discrete data and removing significantly non-linear discrete data items from case of China. Afterward, linear regression analysis was performed on the remaining 39 country data, and the test data are shown in Tables 14&15. The average value of manufacturing gross domestic product changed from $319.47 billion as shown in Tables 12&13 to $199.87 billion as shown in Table 9, while the values of the other variables remained relatively unchanged. This indicates that the manufacturing gross domestic product of China Mg has a significant impact on the overall mean and is much higher than other countries. There is a non-linear growth control variable in the fifth dimension. However, adding or removing Chinese data has a minimal effect on the mean of the other five control variables, indicating that China and the other 39 case bodies have the same linear effectiveness in terms of the dimensions of these five control variables (Y_{ω}, L_p, H_p, G_i, F_g). China is also influenced by these five control variables. After removing the Chinese data, the remaining 39 case bodies were verified according to the research theoretical model, showing a good linear fit. Empirical test data are shown in Tables 14&15.

Table 14. Regression Analysis of Manufacturing Resource Endowment and International Competitiveness Model - 39Countries: Descriptive statistics

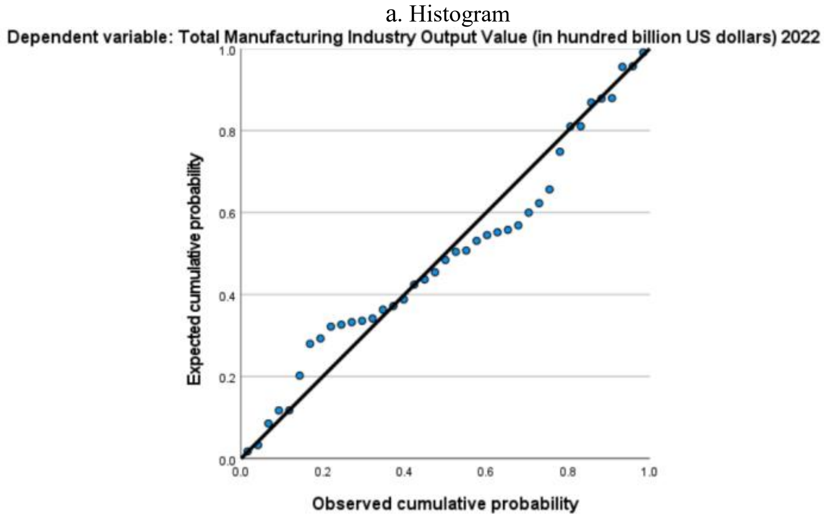
	mean	Standard deviation	Number of cases analyzed
Total Manufacturing Industry Output Value (in hundred billion US dollars) 2022	1.99871858	4.721447848	39
Logistics Performance Index for Infrastructure 2023	2.6103	1.44382	39
Higher Education Power Index 2023	16.3590	18.04889	39
Comprehensive Innovation Index 2023	2.1687	1.06503	39
Average GDP Growth Rate for the Past Five Years (2018-2022)	2.3718	3.37381	39
Manufacturing Industry Resource Endowment Index 2022	5.4103	2.19411	39

Table 15. Regression Analysis of Manufacturing Resource Endowment and International Competitiveness Model - 39Countries: Model Summary b

Model	R	R Square	Adjusted R Square	Standard Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	1df1	2df2	Significance of F Change	
1	.953 a	.908	.894	1.538048687	.908	65.018	5	33	.000	1.880



a. Histogram



b. Normal P-P Plot of Regression Standardized Residuals

Figure 6: Regression Analysis of Manufacturing Resource Endowment and International Competitiveness Model - 39Countries.

Based on the data in Tables 14&15 and Figure 6, an analysis of the fit and predictive performance of the regression model was conducted. In this model, the R value is 0.953, indicating that the independent variables can explain approximately 95.3% of the variation in the dependent variable. The R-squared value is 0.908, indicating that the independent variables can explain approximately 90.8% of the variation in the dependent variable. The adjusted R-squared value is 0.894, and the standard error estimate has decreased from 5.7075 (as shown in Table 13) to 1.538. The Durbin-Watson value of 1.881, close to 2, indicates that the error terms are relatively independent of each other. Overall, based on these indicators, it can be seen that the regression model has a good fit and the independent variables have a significant explanatory power for the dependent variable. Except for China, the economic cases of other countries or regions are in line with and validate the relevancy of the theoretical model and the hypothesis of influencing factors. The relationship model between manufacturing GDP Mg (in billions of US dollars) and its manufacturing resource endowment index Y_{ω} is as follows:

$$Mg_{39} = 0.54 + 0.042 \times Y_{\omega} + 0.228 \times L_p + 0.326 \times H_p - 2.274 \times G_i + 0.096 \times F_g \quad (2)$$

2) Manufacturing powerhouses/develop-able full industrial chain economies - regression model on manufacturing resource endowment and international competitiveness. To further assess the validity of the model data, due to the varying degrees of missing data for the relevant variables of 21 countries with manufacturing GDP below 30 billion US dollars, there is a certain proportion of estimated data, not first-hand data. Therefore, these 21 countries are excluded, and instead, major developed manufacturing countries with manufacturing resource endowment index Y_{ω} values close to 5 to 10 (Y_{ω} with an average close to 7) are selected as the sample group for statistical analysis. These countries include Japan, South Korea, Malaysia, Thailand, the Philippines, Indonesia, Pakistan, Russia, Canada, China, the United States, Germany, the United Kingdom, France, Australia, Argentina, India, Brazil, and Mexico. As a suitable sample group for the development of a full industrial chain manufacturing economy model, statistical analysis was conducted based on the theoretical model of this study, and the test data are shown in Table 16 as follows:

According to the data in Table 16, an analysis of the fit and predictive performance of the regression model was conducted. The R squared value has increased to 0.837, indicating that the independent variables can explain approximately 83.7% of the variation in the dependent variable. The adjusted R squared value has increased to 0.584, which means that after correcting for the complexity of the model, the explanatory power is at 58.4%. These indicators suggest that the fitting ability of the regression model has improved compared to the Model Mg_{40}, and the explanatory power of the independent variables on the dependent variable is significant.

Table 16. Regression Analysis of Manufacturing Resource Endowment and International Competitiveness Model - 19 Countries.

Model Summary [b]										
Model	R	R Square	Adjusted R Square	Standard Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	1df1	2df2	Significance of F Change	
1	.837 [a]	.700	.584	7.793376243	.700	6.061	5	13	.004	2.897

Furthermore, to optimize the above model data, observe the normal distribution P-P plot based on Table 16, and once again remove the data from China to analyze the remaining 18 countries through linear regression. The test data are shown in Table 17. The average manufacturing GDP value has changed from 671.36 million US dollars based on Table 16 to 431.78 million US dollars based on Table 17 with minor changes in the other variable values, as shown in Table 17.

Table 17. Multivariate Regression Analysis of Manufacturing Development Resource Elements and International Competitiveness Evaluation Model - 18 Countries

Model Summary [b]										
Model	R	R Square	Adjusted R Square	Standard Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	1df1	2df2	Significance of F Change	
1	.972 [a]	.945	.923	1.744167821	.945	41.471	5	12	.000	2.314

The relationship model between the manufacturing GDP Mg (in billion US dollars) and its manufacturing resource endowment index Y_{ω} is as follows:

$$Mg_{18} = 5.025 - 0.166 \times Y_{\omega} + 1.232 \times L_p + 0.403 \times H_p - 5.528 \times G_i + 0.306 \times F_g \quad (3)$$

Non-Manufacturing Powerhouse/Not Suitable for Full Industrial Chain Economy - Regression Model of Manufacturing Resource Endowment and National Competitiveness. For the remaining 21 case countries' data analysis, the average manufacturing resource endowment index Y_ω is close to 4, and the manufacturing GDP in 2022 is less than 30 billion US dollars: Liechtenstein, Monaco, San Marino, Città del Vaticano (Vatican City State), Dominican Republic, Timor-Leste, Brunei, Tajikistan, El Salvador, Libya, Estonia, Slovakia, Latvia, Slovenia, Singapore, Laos, Cambodia, Bolivia, Nepal, Colombia, and Bangladesh. These countries, as a case group that is not entirely suitable for developing a full industrial chain manufacturing economy, were analyzed through regression analysis based on the theoretical model of this study. The test data are shown in the following Table 18:

Table 18. Multivariate Regression Analysis of Manufacturing Development Resource Elements and International Competitiveness Evaluation Model - 21 Countries

Model Summary [b]										
Model	R	R Square	Adjusted R Square	Standard Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	1df1	2df2	Significance of F Change	
1	.806[a]	.649	.532	0.007355516	.649	5.546	5	15	.004	1.600

The relationship model between manufacturing GDP (in billion US dollars) Mg and its manufacturing resource endowment index Y_ω is as follows:

$$Mg_{21} = -0.007 + 0.002 \times Y_\omega + 0.001 \times L_p + 0.0002 \times H_p - 0.003 \times G_i + 0.0001 \times F_g \quad (4)$$

Due to the speculative nature of some data in this group, there may be inaccuracies in the model coefficients. However, based on the positive and negative relationships between the coefficients, it can be inferred that for underdeveloped or developing countries with lower manufacturing resource endowment index values (average 4.3 for the 21 case countries in this group), the comprehensive innovation index positively affects their manufacturing GDP. On the other hand, for countries that are suitable for developing a full industrial chain or are manufacturing powerhouses, the comprehensive innovation index G_i has a negative correlation with manufacturing GDP Mg. This verifies the notion that as an economy's manufacturing sector develops, high-end manufacturing gradually dominates in terms of value. Meanwhile, increasing labor costs can lead to changes in the country's manufacturing resource endowment index, turning labor cost advantages into disadvantages for the lower-end manufacturing market. If these countries fail to adopt a hierarchical development approach for the manufacturing industry's full industrial chain, it may result in resistance and a decrease in overall manufacturing competitiveness. Therefore, for most developed manufacturing countries, their current strategic approach is focused on dominating and maintaining a high-profit position in the mid-to-high-end manufacturing market, while opting for international allocation and outsourcing for lower-end manufacturing. This leads to an initial increase and subsequent decrease in the Mg index. In the Mg_{18} model of the 18 developed manufacturing countries, the coefficient of Y_ω and G_i is negative and Y_ω is negatively correlated with Mg. Conversely, for underdeveloped manufacturing economies or those unsuitable for a full industrial chain economy, the coefficient of Y_ω and G_i is positive and Y_ω is also positively correlated with Mg.

VI. Conclusion and Insights

A. Manufacturing Competitiveness and Decision-Making Model

Based on historical data and analysis of the development history of manufacturing industries in various countries around the world, the "Resource Endowment and International Competitiveness Model" obtained can effectively explain the current status of manufacturing resource endowment and international competitiveness in a non-"full industrial chain" mode. It provides an analytical tool and reference value for evaluating the current development status and direction of manufacturing industries in different economies/countries. In summary, the research analysis yields the following *Manufacturing Resource Endowment and International Competitiveness Model*:

① Model for economies not suitable for developing a full manufacturing industry or for underdeveloped manufacturing economies, with conditions: $0 \leqq Y_\omega < 4$, $Mg \leqslant 300$ billion USD:

$$Mg_{\text{Not suitable for full industry chain}} = -0.007 + 0.002 \times Y_\omega + 0.001 \times L_p + 0.0002 \times H_p - 0.003 \times G_i + 0.0001 \times F_g \quad (5)$$

② Model for developed economies suitable for developing a full manufacturing industry chain, with conditions: $5 \leqq Y_\omega \leqslant 10$, 300 billion USD$\leqslant$ Mg :

$$Mg_{\text{Suitable for full industry chain}} = 5.025 - 0.166 \times Y_\omega + 1.232 \times L_p + 0.403 \times H_p - 5.528 \times G_i + 0.306 \times F_g \quad (6)$$

③ "Resource Elements and International Competitiveness Model" in manufacturing industries under a non-"full industrial chain" mode, with conditions: $0 \leqq Y_\omega < 10$:

$$Mg_{39} = 0.54 + 0.042 \times Y_\omega + 0.228 \times L_p + 0.326 \times H_p - 2.274 \times G_i + 0.096 \times F_g \quad (7)$$

B. Strategic Thinking Based on the Development Model of Full Industry Chain

If the control variable indicators for China in 2022 are inputted into *the Resource Endowment and International Competitiveness Model* under the non-full industry chain mode, the value of 39 is 13.61264 trillion USD. However, the actual value Mg in 2022 is 49.83812 trillion USD, which is 3.661 times the level of manufacturing output in the world economy under the same conditions of 5 control variables (Y_ω, L_p, H_p, G_i, F_g). This significant difference in the sixth control variable that exists in China's manufacturing development deserves further exploration and discovery. The development strategy of China's manufacturing industry has the characteristics of innovative era, which differs from the development strategies of other historical and current manufacturing powerhouses. Therefore, there is a phenomenon of high- Mg value deviation and extreme discreteness in the co-linearity fitting verification of the data. This indicates that the sixth control variable exists in China's manufacturing development and currently only exists as a unique case in China, while most other economies in the world have not yet applied this control variable strategy to stimulate the momentum of their manufacturing industries. Researching and clarifying this unique variable and applying it in a reasonable manner, combined with the national conditions, will be meaningful and valuable for the development and breakthrough of the world's manufacturing economies.

$$Mg_{39\,\text{China}} = 0.54 + 0.042 \times 8.75 + 0.228 \times 3.7 + 0.326 \times 58 - 2.274 \times 3.39 + 0.096 \times 6.9 = 13.61264$$

It is not difficult to see that China is exploring a path for economic development that suits its national conditions - the path of a manufacturing powerhouse/country with a full industry chain. Based on the superpower's strong domestic market, China develops manufacturing industries at different levels, including low-end, middle-end, and high-end. In fact, this strategy is suitable for any economy or country with a huge population base (with hundreds of millions of people) and vast territory (with an economic ladder and differentiated markets). The gradient development of the middle and low-end manufacturing industries can provide employment opportunities for the country's large labor force and also provide abundant products and services for the middle and low-income groups. The development of middle and high-end manufacturing industries can be based on the value of the international manufacturing supply chain, and pursue the best allocation ratio and welfare based on their own technological capabilities and value, in order to obtain the value and status for further development.

C. Institutional Superiority for Safeguarding Economic Vitality

In recent years, economies in capitalist countries such as South Korea and Japan have encountered significant problems and challenges, with issues such as declining birth rates, population outflow, and pension concerns exacerbating the decline in economic vitality. The underlying reason is the closure of social mobility channels. When the majority of young people today believe that they cannot change their less-than-ideal living conditions no matter how hard they try, they are inclined to give up fighting for success and choose a "lying flat" lifestyle. Consequently, the entire society loses its economic development vigor and driving force, leading to a vicious cycle of consumption, employment, and economic decline.

With the development of the global economy, China's institutional superiority in economic development has become apparent. It is more conducive to breaking through the bottlenecks hindering economic vitality based on overall interests, ensuring smooth channels for social mobility among different economic classes (proletariat, middle class, high net worth individuals). With hope, one can continue to strive relentlessly.

Although China's education system inevitably faces various issues and urgent needs for optimization, it still maintains a relatively fair and effective allocation system based on the educational resources of the vast majority of students' academic abilities. It serves as a system for cultivating all types of high-quality talent for the country and possesses a huge scale and capacity, covering almost all hundreds of millions of young people in need of education domestically. As long as individuals hold onto their dreams and are willing to work hard, the education system allows every ordinary person to access higher levels of resource allocation channels through self-learning and growth processes such as academic achievements and entrepreneurship, enabling social mobility and advancement among economic classes. Of course, the initial distribution considers efficiency, while the secondary distribution emphasizes fairness, as seen in the provision and construction of public services such as education, healthcare, poverty alleviation, disaster relief, and other social public undertakings.

D. The Life-cycle of Manufacturing Industry

The life-cycle of the manufacturing industry is generally divided into four stages:

1) Primary Stage - Development of Mid to Low-End Manufacturing: This is the initial stage of the manufacturing industry, characterized by limitations such as market conditions, technology, labor skills, and capital. Typically, mid to low-end manufacturing dominates during this phase.

2) Intermediate Stage - Development of High-End Manufacturing: As the market evolves and initial accumulation is achieved, with increasing labor skills and costs, the industry gradually transitions towards high-end manufacturing.

Advanced Stage - Global Layout of Manufacturing Supply Chain: This stage can be further divided into two development directions. For countries and economies with abundant manufacturing resources (with a score of 5 or above in terms of manufacturing resource endowment), after establishing a significant market share in high-end manufacturing, they generally shift focus towards the international layout of the manufacturing supply chain. This involves positioning the country as a technological base for high-end manufacturing, coordinating the production and market layout of mid to high-end manufacturing globally, gradually moving away from low-end manufacturing markets, and fulfilling the demand for domestic mid to low-end manufacturing products through international procurement. On the other hand, for countries or economic regions with weak manufacturing resource endowment (with a score below 2-3), the focus is on the layout and positioning of industries with high value-added dimensions such as technical support for mid to high-end manufacturing, in alignment with strong manufacturing nations participating in the global industrial chain.

Both paths require control over global consumption and production material markets. Loss of control could lead to entering a stage of free market competition, jeopardizing the maintenance of a high value-added global supply chain layout and positioning. However, from the perspective of global resource allocation and fair market competition, the stage of free market competition represents the ideal and sustainable era of economic activity for humanity.

3) Unlimited Development Stage - Comprehensive Development of Manufacturing Industry Chain: This involves leveraging the considerable domestic market demand and manufacturing capabilities to compete and develop different layers and regional markets for mid, high, and low-end manufacturing through domestic free market competition. Simultaneously, actively participating in global competition and trade activities in mid, high, and low-end manufacturing markets to provide more efficient products, services, and value systems to the world, contributing to and promoting the evolution and arrival of the era of global free market economy.

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