Multi-Factor Multi-Objective Optimal Industry Investment Strategy

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Abstract: Since the introduction of the "New Normal" in 2012, China’s economic development has gradually shifted toward high-quality growth. By 2023, the tertiary sector accounted for 54.6% of GDP, becoming the main driver of economic expansion. However, emerging industries still require government guidance to ensure orderly development. Based on panel data from multiple industries spanning 1990 to 2023, this paper constructs an industrial network graph and employs multiple regression models to systematically analyze inter-industry linkages, marginal contributions to GDP, and investment spillover effects. The study reveals that when the government prioritizes GDP growth alone, mechanical manufacturing receives the highest investment; when both GDP growth and social equity and environmental sustainability are considered, agriculture receives more investment; and when GDP growth, unemployment, social equity, and environmental sustainability are jointly considered, IT services become the top investment choice.

1. Summary

Since the emergence of the "New Normal" in 2012, China's economic growth has steadily shifted towards high-quality development, accompanied by a profound transformation in its industrial structure. The focus of the country's industries is shifting from traditional manufacturing to high-tech industries, services, and emerging sectors such as artificial intelligence, biotechnology, and new energy. By 2023, the contributions of the primary and secondary industries to GDP had dropped to 7.1% and 38.3%, respectively, while the tertiary industry rose to 54.6%, becoming the main driver of economic growth. However, due to challenges faced by emerging industries in talent development and resource allocation, the government must promote the rational development of these emerging sectors, avoid over-dependence on any single industry, and foster balanced industrial growth to ensure stable and sustainable economic development. At the same time, the government must play a key role in promoting employment, sustaining development, and improving social equity.

A review of the latest relevant research literature reveals the following: Regarding the interaction between industries and the impact of related industries on the economy, complex network analysis methods have been used to analyze industrial association networks, creating models of industrial nodes and node subsets. From the perspective of industrial subgroups, existing literature often employs methods such as n-cliques and n-clans. Guo Kunjian (2022) used the Weaver-Thomas comprehensive index model to identify strong association relationships and found that China’s association network has relatively poor correlation, with significant clustering phenomena, but the development of industrial subgroups is unbalanced[1].Wu Maohua and Wang Dihai (2024) demonstrated through the interaction of industrial associations that industrial development is positively correlated with service development, but inhibits agricultural development, with service development in opposition to agricultural development[2]. Zhou Tiantian (2015) analyzed the interaction between industrial ecosystem layout and resource allocation and the development of ecological economic systems and ecologicalization[3]. Wang Wei et al. (2023) studied the impact of industrial structure differences on regional wealth gaps from the perspective of different regions,

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which can reflect the impact of industrial relationships on investment strategies for the three industries and their economic effects[4]. Liu Congke (2020) found that the higher the level of economic development, the weaker the effect of an increase in the share of agricultural employment on economic growth[5]. Before and after 2013, the role of agriculture in economic growth became insignificant, and regional economic development shows heterogeneity at different stages of economic development.

In summary, most literature studies the impact of a single indicator on the economy or a particular aspect of the issue, lacking comprehensive analysis of the total impact of multiple industries. This paper will base its analysis on the correlation among major domestic industries, comprehensively consider the interdependencies and constraints among industries, and evaluate the impact of different industries on the economy, thereby deriving the optimal domestic industrial investment strategy.

2. Model Construction and Data Processing

2.1 Model Assumptions

To simplify the analysis and ensure robustness, we make the following reasonable assumptions:

Firstly, the total government investment is fixed at 1 trillion yuan, with all allocation plans adjusted and optimized within this budget.

Secondly, each industry's investment must meet its historical minimum proportion to maintain the normal operation of fundamental industries and ensure stable economic growth.

Thirdly, the impact of investments in each industry on Gross Domestic Product (GDP) is assumed to be independent. Investment effects are calculated separately to avoid increased model complexity arising from inter-industry competition or synergy.

Fourthly, the policy environment and market conditions are assumed to remain stable throughout the investment optimization period, ensuring that they do not significantly influence investment outcomes.

2.2 Data Description

To comprehensively analyze the coverage and complex interrelationships of China's national economy, this paper utilizes data spanning from 1990 to 2023. The data sources include the China Statistical Yearbook, the National Bureau of Statistics, Google Scholar, and CNKI (China National Knowledge Infrastructure).

Firstly, the dataset contains value-added and industrial investment data from representative industries in China, aiming to fully reflect the composition of Gross Domestic Product (GDP) and investment structure. Specifically, these industries include agriculture, forestry, animal husbandry, and fishery; mining; chemical industry; metal manufacturing; machinery manufacturing; power supply; textile and apparel; food and beverage; other manufacturing; construction; wholesale and retail; IT services; finance; and hospitality.

Secondly, when studying employment promotion, the dataset incorporates key employment-related indicators, such as the urban unemployment rate and employment numbers across the aforementioned industries.

Furthermore, in examining sustainable development and social equity, the dataset includes indicators such as unit GDP energy consumption, renewable energy generation, poverty rate, Gini coefficient, and the economic cost of carbon dioxide emissions.

Due to the presence of outliers, missing values, and non-annual records in the data, preprocessing is necessary, including outlier cleaning, missing data imputation, and unit conversion. For numerical data, linear interpolation is primarily used to estimate missing values to ensure data continuity. For missing values at the beginning or end of the dataset, where no adjacent points are available for support, forward filling or backward filling methods are applied. Non-numerical data are not subject to imputation.

Based on the processed data, the line chart is presented as the Figure 1, during 1990 to 2023, the proportion of China’s primary industry gradually declined, transitioning from a growth model dominated by the secondary industry to a service-oriented economy led by the tertiary industry. The rapid rise of the tertiary industry has become a significant driving force behind the growth of GDP.

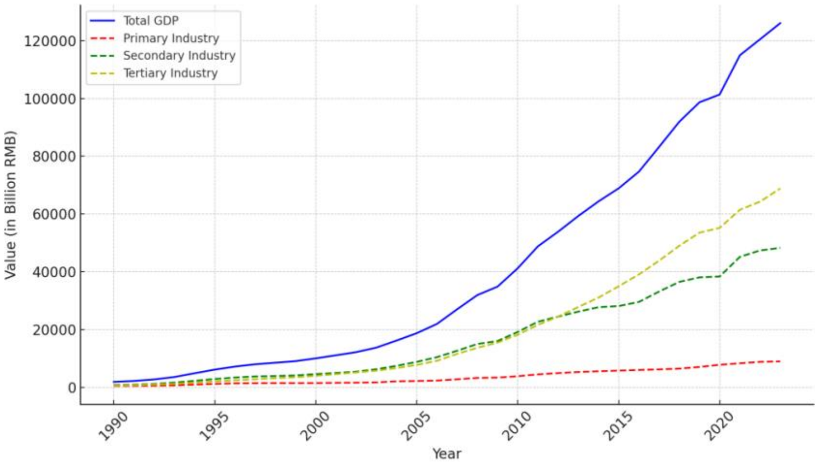

Figure 1 Changes in Chinese GDP and Industries Value Added (1990–2023).

3. Analysis of Investment Strategy Elements

In this section, an industrial network diagram is first constructed by analyzing inter-industry correlations to reveal the synergies between core and peripheral industries. Then, a linear regression model is employed to analyze the contribution of various industries to GDP, highlighting the particularly significant role of modern service sectors such as IT services and finance. Finally, a multiple regression model is used to examine the impact of industrial value added on key economic and social indicators. The above analyses provide a theoretical foundation for achieving the multiple goals of economic growth, social harmony, and environmental sustainability discussed in the following sections.

3.1 Analysis of inter-industry correlations

To analyze the correlations among various industries and assess their interdependencies, this study constructs an industrial network diagram based on inter-industry correlations, using the correlation coefficient threshold of 0.9. The nodes and links in the diagram visually represent the economic structure and the synergies among industries. As shown in Figure 2, core nodes—such as GDP, value added of the secondary industry, and the electricity industry—are closely connected with multiple sectors, indicating their critical role within the economic network. In contrast, peripheral nodes—such as value added in the textile and apparel industry and other manufacturing sectors—exhibit a higher degree of independence, with weaker connections to other industries, reflecting their auxiliary and localized roles within the broader economic structure.

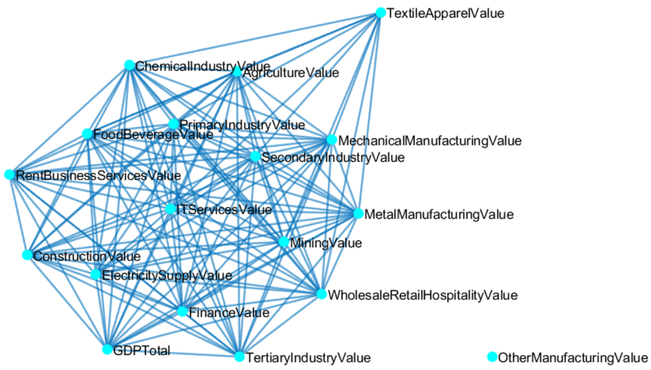

Figure 2 Industrial network structure.

3.2 Analysis of the Economic Growth Effects of Industries

This section assumes that GDP can be represented as a linear combination of internal factors. A linear regression model is established to evaluate the contribution of each industry to GDP. The model is as follows:

$$GDP_t = \beta_0 + \sum_{i=1}^{m} \beta_i \cdot X_{it} + \epsilon_t \quad (1)$$

GDP_t represents the GDP in year t, and X_{it} is the value added by industry i in year t, which indicating the industry's contribution to the total GDP. β_i is the regression coefficient for each industry, which reflecting its marginal contribution to GDP.

The regression estimation results are shown in the Table1.The results show significant differences in the contributions of various industries to GDP. The coefficient for agricultural value added is 0.96, indicating a significant contribution to the primary industry. The coefficient for value added in the construction industry is 2.20, suggesting a strong positive impact on the secondary industry. In contrast, industries such as metal manufacturing and machinery manufacturing exhibit insignificant negative effects. Finally, IT services, wholesale and retail, and leasing services have significant positive impacts on the tertiary industry. The financial industry, possibly due to its indirect role in driving economic growth, does not show a significant effect on the growth of the tertiary sector.

Table 1 Regression Results of Each Industry's Contribution to GDP

Dependent Variable	Primary Industry	Secondary Industry	Tertiary Industry
Agriculture Value Added	0.96 *** (0.02)		
Other Manufacturing Value Added		1.58 (1.47)	
Chemical Industry Value Added		8.27 (6.03)	
Construction Value Added		2.20 ** (1.05)	
Mining Value Added		-1.07 (1.78)	
Metal Manufacturing Value Added		1.58 (1.47)	
Mechanical Manufacturing Value Added		-2.15 (2.33)	
Electricity Supply Value Added		3.17 (2.47)	
Textile Apparel Value Added		2.61 (6.50)	
IT Services Value Added			2.84 *** (0.47)
Finance Value Added			0.12 (0.97)
Food Beverage Value Added			-0.72 (1.16)
Wholesale Retail Hospitality Value Added			1.71 ** (0.65)
Rent Business Services Value Added			3.04 ** (1.12)
Intercept	-1856.18 ** (768.37)	-16736.77 (17437.09)	2742.73 (2429.18)
Sample size	34	34	34
R^2	0.991	0.998	0.999

Note: ***, **, * represent significance levels of 1%, 5%, and 10%, respectively; the values in parentheses are t-values. The same applies below.

3.3 Analysis of the Economic Growth Effects of Investment

Based on the above analysis, this section further explores the role of investment in China's economic development. Investment is not only a key instrument of macroeconomic regulation, but also an irreplaceable driver of national economic growth. A rational allocation of investment contributes significantly to promoting economic development. Therefore, this section focuses on sectors such as agriculture, manufacturing, and IT services, using a linear regression model to analyze the contribution of industry-specific investment to sectoral growth. The model is specified as follows:

$$V_t = \alpha_0 + \alpha_1 I_t + \epsilon_t \tag{2}$$

V_t is the value added of the given industry in year t, I_t represents the investment in that industry in the year t, α_1 is the investment coefficient,which indicating the marginal contribution of investment to the growth of industry value added. The regression model results for industry investment and GDP are shown in the Table 2.

Table 2 Marginal Contribution of Industry Investment

Industry	Investment Coefficient	Number of Observations	R^2
Agriculture	0.6286*** (0.0069)	24	0.9973
Chemical Industry	0.1508*** (0.0025)	24	0.9942
Construction	0.2519*** (0.0031)	24	0.9966
IT Services	0.4084*** (0.0037)	24	0.9982
Finance	0.7069*** (0.0079)	24	0.9973
Food Beverage	0.2338*** (0.0050)	24	0.9902
Wholesale Retail Hospitality	0.5510*** (0.0086)	24	0.9947
Mechanical Manufacturing	0.1890*** (0.0027)	24	0.9955
Rent Business	0.4812*** (0.0097)	24	0.9912
Textile Apparel	0.1821*** (0.0047)	24	0.9858
Electricity Supply	0.2942 *** (0.0134)	24	0.9564
Mining	0.5621*** (0.0234)	24	0.9195
Metal Manufacturing	0.2181*** (0.0132)	24	0.9251
Other Manufacturing	0.3567*** (0.0234)	24	0.9821

Note: ***, **, * represent significance levels of 1%, 5%, and 10%, respectively; the values in parentheses are t-values. The same applies below.

The spillover effect refers to the phenomenon where investment in one industry not only influences its own development but also has indirect impacts on other industries. The investment coefficient reflects the extent of this effect. As shown in Table 2, industries such as agriculture, the chemical industry, construction, IT services, and finance all have positive investment coefficients, indicating a significant positive impact on GDP. Among them, industries like agriculture (0.6286) and the chemical industry (0.1059) exhibit relatively low spillover effects. In contrast, sectors such as IT services (0.4084) and finance (0.7069) demonstrate strong spillover effects, likely due to their role in driving technological innovation and enhancing productivity in other sectors. This generates a "spillover" impact, fostering growth in related industries and forming notable externalities. The financial sector shows especially pronounced positive externalities from its investments.

4. Analysis of Promoting Employment Elements

Improving people's well-being, maintaining social stability, and reducing the unemployment rate are key goals of China's economic and social development. Therefore, in the process of promoting industrial transformation, investment should fully take into account its impact on employment pressure. This section constructs a multiple linear regression model to analyze the relationship between employment in various industries and GDP, in order to quantify the effect of employment numbers on the GDP of the corresponding sectors. The specific linear regression model between employment in the three major industries and GDP is as follows:

$$\mathrm{V}_t = \gamma_0 + \sum \gamma_{it} \cdot \mathrm{Employment}_{it} + \epsilon_{it} \tag{3}$$

V_t represents the value added of the three major industries in year t, and $\mathrm{Employment}_{it}$ denotes the number of employees in industry i in year t, γ_0 is the intercept term, and ϵ_{it} represents the error term.

Table 3 Correlation between Industry Value Added and Employment

	Primary Industry Value Added	Secondary Industry Value Added	Tertiary Industry Value Added
Employment Farming	-130.7437*** (5.3619)		
Employment Mining		-620.9076* (355.71)	
Employment Manufacturing		70.3892 (106.11)	
Employment Electricity		4049.4204*** (1254.2)	
Employment Construction		-131.2900** (58.987)	
Employment Transport Storage			-371.0548 (417.12)
Employment IT			476.7198 (443.84)
Employment Wholesale Retail			92.5232 (153.85)
Employment Accommodation Catering			-283.5633 (259.31)
Employment Finance			-20.9029 (219.8)
Employment Real Estate			247.1820** (109.5)
Employment Rent Business			237.3576 (169.39)
Employment Research Tech			-317.3147 (395.27)
Employment Water conservancy environment			393.2259 (842)
Employment Other Services			-1481.8384 (1432.5)
Employment Education			-446.8796*** (136.23)
Employment Health Social			684.3911 (501.06)
Employment Culture Sports			-2.7970 (687.42)
Employment Public Admin			157.4690 (162.05)
sample	24	24	24
R^2	0.947	0.894	0.999

Note: ***, **, * represent significance levels of 1%, 5%, and 10%, respectively; the values in parentheses are t-values. The same applies below.

The regression results are shown in Table 3. In industries such as agriculture, mining, and construction, there is a significant negative correlation between employment and investment. This indicates that with the advancement of automation and mechanization, traditional labor-intensive jobs are increasingly being replaced by efficient machinery, reducing reliance on low-skilled labor.In contrast, the electricity and real estate industries show a significant positive correlation between employment and investment. As economic expansion and urbanization progress, rising demand for energy and housing has created more employment opportunities in these sectors.

5. Analysis of Social Equity and Environmental Sustainability Elements

Social equity and environmental sustainability are essential factors that must be considered in fixed investment decision-making. This section constructs a multiple linear regression model to analyze the impact of various industries on key economic and social indicators. Using the value added of the primary, secondary, and tertiary industries as independent variables, regression analyses are conducted on indicators such as energy consumption, renewable energy usage, poverty rate, Gini coefficient, natural resource depletion rate, and CO_2 damage costs.

$$Y_t = \beta_0 + \sum_{i=1}^{3} \beta_i IV_{it} + \epsilon_t \tag{4}$$

In the model, Y_t represents indicators of social equity and environmental sustainability, such as energy consumption, IV_{it} denotes the value added of the three major industries, and ϵ_t is the error term. The regression results are presented in Table 4. The value added of the primary industry has a significant negative impact on energy consumption and the natural resource depletion rate. The value added of the secondary industry shows a positive impact on renewable energy generation and the natural resource depletion rate, with a particularly significant effect on carbon dioxide emissions.The value added of the tertiary industry exhibits a certain negative impact on energy consumption, poverty rate, and natural resource depletion rate.

Table 4 Regression Results of Social Equity and Environmental Sustainability Indicators

	Energy Consumption per Unit of GDP	Renewable Energy Generation	Poverty Rate	Gini Coefficient	Natural Resource Depletion Rate	CO_2 Damage Costs
Value Added of the Primary Industry	-113.19*** (38.94)	-0.0117 *** (0.004))	-0.0055 (0.001)	0.006 ** (0.002)	-0.0011*** (0.0003)	7.576×10^5 (1.01×10^6)
Value Added of the Secondary Industry	7.70 (7.74)	0.0031 ** (0.001)	0.0003 * (0.000)	0.0001 (0.000)	0.0006** (0.0002)	1.235×10^6 *** (2×10^5)
Value Added of the Tertiary Industry	4.87 * (2.39)	0.0005 ** (0.000)	0.0001 (0.000)	0.0002 (0.000)	-0.0002** (0.0001)	-1.942×10^5** (6.18×10^4)
Intercept	391.37	74870.21	72.80	32.20	5.41	1.125×10^{10}
Sample size	34	34	34	34	34	34
R^2	0.810	0.823	0.982	0.801	0.789	0.996

Note: ***, **, * represent significance levels of 1%, 5%, and 10%, respectively; the values in parentheses are t-values. The same applies below.

6. Analysis of Investment Strategies under Different Objectives

When making investment decisions, government comprehensively considers key indicators such as GDP growth, unemployment rate, social equity, and environmental sustainability to achieve a balance between economic development and social benefits. This section presents a model that defines the regression relationships between investments in various industries and GDP, along with reasonable value ranges for the key indicators, to jointly address the trade-off between economic growth and social outcomes. GDP growth is set as the primary objective function, while urban unemployment, social equity, and environmental sustainability factors are introduced as constraints.

By adjusting the investment allocation scheme, the model searches for a global optimal solution. The upper and lower bounds of industry-specific investments are determined based on historical data and reasonable buffer ranges. The optimization results include the optimal investment allocation, the corresponding contribution to GDP, predicted values of the key indicators, and comparisons with their acceptable ranges. Finally, since social equity and environmental sustainability involve multiple sub-indicators, principal component analysis (PCA) is applied for dimensionality reduction.

First, the objective function is constructed, where the investment strategy is optimized by minimizing the objective function. As shown below, R represents the urban unemployment factor, reflecting social welfare and employment conditions, while E represents the social equity and environmental sustainability factor, capturing the combined effects of energy use, resource depletion, and related aspects. λ_1 and λ_2 are weighting parameters used to balance the optimization objectives of GDP growth, unemployment, and environmental impact.

$$\mathrm{Obj}(x) = -(\mathrm{GDP} - \lambda_1 \cdot \mathrm{R} - \lambda_2 \cdot \mathrm{E}) \tag{5}$$

Secondly, the model for the environmental impact factor is constructed as follows. R represents the urban unemployment rate, and IV_i denotes the investment amount in industry i. γ_i and δ_i represent the coefficients capturing the impact of the investment amount and its squared term, respectively, on the urban unemployment rate. These coefficients are estimated through a regression in which R is the dependent variable, and IV_i and ${\mathrm{IV}_i}^2$ are the independent variables.

$$\mathrm{R}=\gamma_0 + \sum \gamma_i \mathrm{IV}_i + \delta_i \cdot {\mathrm{IV}_i}^2 \tag{6}$$

Thirdly, the constraints are as follows: the total investment constraint and the upper and lower bounds of industry investments. $\mathrm{x_i}$ represent the total investment amount, which is less than one trillion. $\mathrm{lb_i}$ denotes the lower bound of historical investment for industry i, and $\mathrm{ub_i}$ represents the upper bound of historical investment for industry i.

$$\sum_{i=1}^{12} \mathrm{x_i} = \text{Total Investment} \leq 1 \times 10^{12} \tag{7}$$

$$\mathrm{lb_i} \leq \mathrm{x_i} \leq \mathrm{ub_i} \tag{8}$$

We have set a buffer range based on historical investment, adding a certain degree of flexibility. When only considering the maximization of GDP and disregarding various social factors, the allocation of various types of investment is as shown in Figure 3 Industrial Investment Allocation.

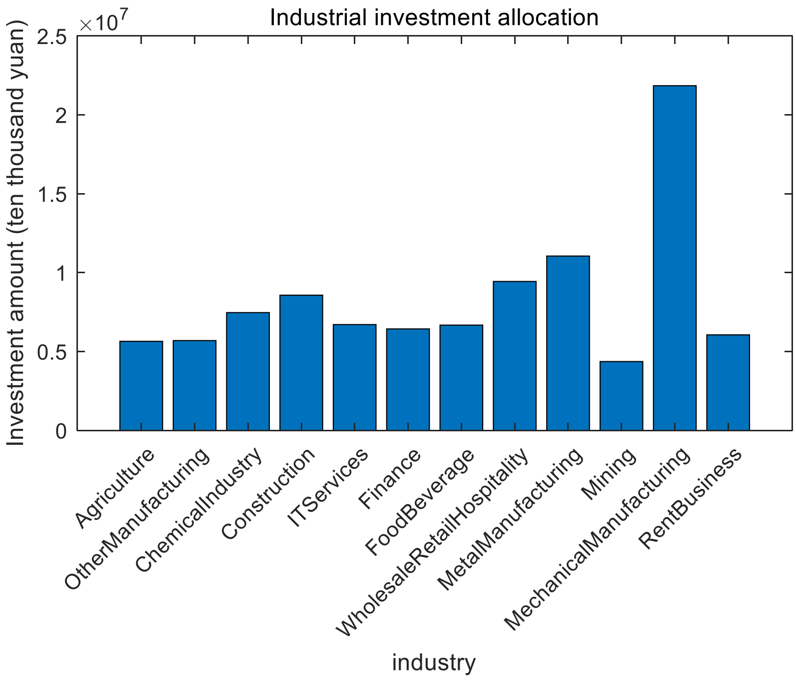

Figure 3 Industrial Investment allcoation

Next, we reasonably assign weights to the unemployment factor and the environmental factor, and filter the data to include only cases where the unemployment rate is below 5.5%, as shown in Table 5. As the values of λ_1 and λ_2 vary, the maximum investment industry fluctuates significantly. For example, when the goal is to achieve a higher level of social equity and environmental sustainability, agriculture receives the highest investment. When both low unemployment and high levels of social equity and environmental sustainability are pursued, IT services receive the highest investment. This indicates that IT services, as a key component of the modern information technology industry, can foster new business models and drivers of economic growth through rapid development. From the perspective of industrial sustainability, the sector is undergoing fast-paced technological iteration and innovation, with emerging technologies such as artificial intelligence, blockchain, and the Internet of Things constantly creating new opportunities for growth.

Table 5 Changes of the Highest Investment Industry under Different Weight Settings

λ_1	λ_2	GDP	Unemployment Rate	Max Investment Industry
10	10	8427776	0.052436	IT Services
0.01	10	7315293	0.006547	Agriculture
10	0.01	5747703	0.035816	IT Services
0.01	1	7225401	0.047672	Other Manufacturing
1	0.1	5312118	0.045487	Construction
10	0.1	5052988	0.033207	Chemical Industry
1	1	1888992	0.028099	Other Manufacturing
1	10	1821738	0.034118	Mining

7. Conclusion

The main conclusion of this article is as follows: Firstly, from the analysis of investment factors, it is found that the construction industry, IT services, wholesale and retail trade, and the leasing and business services industry have a greater positive impact on economic growth. Similarly, IT services and the financial industry have a stronger positive external effect on other industries. From the analysis of employment factors, it is found that the number of employees in agriculture, mining, and the construction industry is negatively correlated with economic growth. On the contrary, the development of the power and real estate industries will bring more employment opportunities. Finally, from the analysis of social equity and environmental sustainability factors, it is found that the development of the primary industry helps to improve energy efficiency and reduce resource consumption. The development of the secondary industry helps to increase energy consumption. The development of the tertiary industry has a negative impact on energy usage, poverty rates, and the rate of natural resource depletion.

From the perspective of investment strategies, if economic growth is the priority and the focus is on the short term, the machinery manufacturing industry and the construction industry should be the main investment targets. If promoting employment is the priority, industries with strong job creation capabilities such as power and real estate should be supported. When considering all three aspects for long-term sustainable development, the IT service industry should be prioritized to drive transformation and achieve coordinated development of the economy, society, and environment. Based on the above research, the following policy recommendations are proposed:

(1) Continuously optimize industrial layout and strengthen industry coordination. On the one hand, the government should make full use of the inter-industry correlation structure, give full play to the leading role of core industries, increase policy support, guide investment flows, and rationally guide social capital to flow into core industries such as the construction industry and IT services to drive the development of downstream industries and improve the overall efficiency of the industrial system. On the other hand, it is necessary to improve the efficiency of capital allocation. According to the differences in the marginal effects of investment in various industries, coordinate the development of industries with high capital utilization efficiency, optimize the investment structure.

At the same time, through improving policy guidance and market mechanisms for industries with lower marginal investment effects, encourage them to improve investment efficiency and achieve transformation and upgrading.

(2) Pay attention to changes in the employment structure and promote the improvement of employment quality. Traditional labor-intensive industries will inevitably decline. Promoting the transformation of traditional labor to high-skilled positions is of great significance. Strengthen the skills training of employees in traditional industries, promote digital education for talents, and facilitate their transformation into new productive forces. For industries with strong job creation capabilities such as power and real estate, appropriate policy support should be given to encourage them to absorb more labor.

(3) Balance social equity and environmental sustainability to achieve green industrial development. Support the primary industry in developing green agriculture and further leverage its advantages in reducing energy consumption and resource consumption. Promote the secondary industry to accelerate the research and application of energy conservation and emission reduction technologies, reduce carbon emission costs, and reduce environmental externalities. Encourage the tertiary industry to fully play its positive role in reducing resource consumption and carbon emissions, and at the same time take measures to promote social equity and narrow the gap between the rich and the poor. To achieve coordinated development of the economy, society, and environment.

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