The Impact of Green Investment on the Upgrading of Industrial Structure in China: Analysis Based on Panel Data Techniques

Heyuan Wang[1,*,a] and Ran Jin[2,b]
[1]*Wuhan University of Technology, Wuhan, China*
[2]*Changchun Normal University, Changchun, China*

Keywords: Green Investment, Upgrading of Industrial Structure, China, Panel Data Techniques.

Abstract: The report of the 19th National Congress of the CPC have proposed to establish and improve a sound economic system for green, low-carbon and circular development. Developing green economy has become the national strategy, and green investment (GIP) will play an important role in developing the green economy. From a global, long-term and strategic perspective, the green economy and the digital economy are mutually reinforcing. The continuous development of the digital economy in recent years has also led to further optimization and upgrading of the industrial structure (ISU). The important role of GIP for ISU in the context of the mutual integration of greening and digitalization has thus emerged. This paper makes full use of panel data techniques and combines with the computer software STATA to empirically test the influence mechanism of GIP on ISU, using 30 provincial panel data of China from 2003 to 2020.The results reflect that GIP has obvious inhibitory effect on ISU. At the meantime, after the 2008 financial crisis, GIP has a more significant inhibitory effect on the ISU. The GIP mainly restrains ISU in the eastern region. In addition, the GIP significantly inhibits the development of primary and tertiary industries but promotes the development of secondary industry.

1 INTRODUCTION

In recent years, the global ecological and environmental problems has become increasingly prominent. Environmental pollution, ecological deterioration and other problems have brought great challenges and threats to human survival and development. Therefore, it is urgent to protect the ecological environment and promote green transformation. On a global scale, developing the green economy is an important part of sustainable development. The data show that GIP has developed rapidly, showing great growth potential in the deep adjustment of the global economy. The data from the United Nations Trade Conference show that global GIP reached $5.2 trillion in 2021, up 63%. The vision of green development has become a goal-oriented and path mode to guide the ISU and achieve high-quality development. Since the 18th National Congress of the CPC, China has incorporated "ecological civilization" into the "five-in-one" overall layout of the socialist cause with Chinese characteristics. As China's economy has shifted from rapid growth to high-quality development, showing leaps and bounds, problems such as irrational industrial structure and inefficient allocation of industrial factors have begun to plague us. The emergence and development of the digital economy has become a new breakthrough in economic development to promote ISU and improve resource allocation efficiency. The digital economy, supported by the development of digital technology and data as an important production factor, has become a new economic form that promotes the development of high-tech industries, the renewal of business models, the comprehensive flow of production factors and the realization of high-quality development. At the same time, technologies such as cloud computing and artificial intelligence in the digital economy can transform the production and operation methods of traditional industries, making energy and electricity, transportation, industrial

[a] https://orcid.org/0000-0003-0341-4092
[b] https://orcid.org/0000-0001-6100-9242

Wang, H. and Jin, R.
The Impact of Green Investment on the Upgrading of Industrial Structure in China: Analysis Based on Panel Data Techniques.
DOI: 10.5220/0012027300003620
In *Proceedings of the 4th International Conference on Economic Management and Model Engineering (ICEMME 2022)*, pages 160-167
ISBN: 978-989-758-636-1

production and other fields The operational efficiency and energy efficiency of these industries have been greatly improved, reducing energy and resource consumption, promoting industrial structure optimization and upgrading, and promoting green economic development. The digital economy not only plays a positive role in promoting the improvement of production efficiency and optimizing industrial structure, but also is becoming a "major carbon emitter" due to factors such as the construction of new infrastructure based on digital technology and the upgrading of data centers, which results in the elimination of old equipment. According to the Index Climate Action Roadmap released by the 2020 Global Climate Action Summit, digital technology solutions in the fields of energy, manufacturing, agriculture, land, construction, services, transportation and traffic management can help reduce global carbon emissions by 15%. Green and low-carbon development is the choice of industrial development direction, and it is also a fundamental issue related to the development of industrial clusters. As an important driving force for energy conservation, emission reduction and green development, GIP will inevitably affect the adjustment of industrial structure in the era of digital economy,. From this point of view, there is a close relationship between ISU and green development. This paper further reveals the relationship between ISU and GIP, and provides new ideas for the green and high-quality economic development, which has important practical significance.

2 LITERATURE REVIEW

The literature closely bound to this paper mainly includes the following two aspects. One is the factors affecting the ISU; the other is the research on green finance and green credit, which are closely related to GIP. Since the reform and opening up, China has comprehensively deepened reform, the innovation-driven strategy has been effectively implemented, the industrial structure has been continuously optimized, and the resilience and advantages of the industrial chain have been improved. As an important way to improve productivity, the adjustment and ISU is of great practical significance to promote economic development (Lv and Zhou, 1999). Therefore, many scholars study how to promote the ISU. Lan and Chen (2013) found that new urbanization has a strong spatial impact on the ISU and can significantly improve the level of industrial development. Moreover, Wang and Zhao (2015) believed that the scale and rationalization of the financial development also promote ISU so it is necessary to build a diversified financial service system, accelerate the reform of the financial system and give play to the guidance of policy-based finance. From the perspective of geography and economy, Guo and Wang (2021) used spatial Dubin model to conclude that the influence of financial agglomeration and housing price on ISU has industry heterogeneity and spatial difference. Liu (2021) discussed the impact mechanism of population aging on the industrial structure from the perspective of the upgrading and rationalization of industrial structure, and concluded that the impact effect of population aging on the ISU and rationalization of industrial structure was significantly positive.

With the aggravation of the world's environmental pollution and energy crisis, energy conservation, emission reduction and the green economic development have become the focus of global attention, and the research on GIP and green finance has become increasingly rich. Zhou et al. (2021) empirically found that green finance improved the comprehensive level of high-quality economic development, promoted the optimization of economic structure and the innovative development of economy, but inhibited the stable development of economy. In addition, other scholars have found that green finance does not simply promote economic development. Shi and Shi (2022) used green total factor productivity to measure the quality of economic development, and concluded that green finance has a threshold effect on green total factor productivity rather than a linear relationship. Only when the development level of green finance was higher than the threshold value could GIP play a significant role in promoting economic development. Zhao and Wang (2022) empirically analyzed the data of listed enterprises in heavy pollution industries in China and concluded that the influence of GIP on business performance of enterprises showed a U-shaped relationship, and the increase of green expenses would reduce business performance of enterprises. On the theme of green development, the influencing factors of GIP are also a hot research topic. Yang (2022) concluded based on the panel data of Shenzhen listed enterprises that after the launch of the carbon trading system, enterprises would enhance their awareness of environmental protection and thus increase their GIP. Xie and Zou (2021) believed that government environmental protection subsidies played an incentive effect on enterprises' GIP, and the promoting effect of market-oriented environmental regulation represented by government environmental subsidies was more obvious in non-state-owned enterprises. Wang and

Hou (2021) made further empirical research and concluded that command-and-control, market-incentive and voluntary environmental regulation tools can all promote GIP of industrial enterprises, and command-and-control environmental regulation tools have the best effect at present.

In summary, there are abundant studies on the two single directions of ISU and GIP, but few studies on the relationship between them. Compared with previous studies, the contributions of this paper are mainly showed in the following aspects. Firstly, the existing literature mainly focuses on the impact of GIP on energy conservation and emission reduction, ignoring the negative impact of GIP on the ISU. The combination of GIP and ISU in this paper is conducive to a more scientific understanding of the impact mechanism of GIP. Secondly, this paper not only studies the direct impact of GIP on ISU from the macro level, but also analyzes the heterogeneity and discusses the impact mechanism, which provides a rich reference for subsequent research. Thirdly, it provides some policy enlightenment for GIP and green development. It is of immediate significance to promote high-quality development of GIP.

3 DATA AND EMPIRICAL MODELS

3.1 Models

In order to study the impact of GIP on ISU, this paper first constructs a panel fixed effect model as shown in Eq. (1).

$$ISU_{it} = \beta_0 + \beta_1 GIP_{it} + \beta_2 GI_{it} + \beta_3 TRADE_{it} + \beta_4 RM_{it} + \beta_5 PD_{it} + \beta_6 TF_{it} + year + city + \varepsilon_{it} \quad (1)$$

Where, ISU is the explained variable, namely the industrial structure upgrading index in this paper. $\beta 0$ is a constant term, and GIP is the core explanatory variable, namely GIP. GI、$TRADE$、RM、PD、TF indicate that control variables affecting the ISU are added into the model, which respectively represent government intervention, trade openness, highway mileage, population density and R&D input intensity. year and city represent the characteristics of time trend and individual differences, respectively. ε is the random disturbance term.

3.2 Variables

The level of industrial structure upgrading. This paper draws on the calculation method of Wang (2015) to measure the ISU. The specific formula is as follows.

$$ISU = \sum x_i \times i$$

Where, xi represents the proportion of added value of the ith industry in GDP.

Since the research on GIP theory is still in its infancy, the theoretical interpretation of GIP is diverse and not unified, and there is a lack of relevant research and data. In this paper, the sum of urban environmental infrastructure investment, industrial governance investment, forestry investment and water conservancy construction investment is selected to measure GIP.

In order to control the endogeneity problem caused by omitted variables, government intervention, trade factors, highway mileage, demographic factors and technological factors are introduced into the model as control variables. Government intervention (GI), TRADE (TRADE) and technical factor (TF) are the proportions of fiscal expenditure, total import and export TRADE and R&D internal expenditure in total GDP, highway mileage (RM) is the total mileage of highway construction, and population factor (PD) is calculated by population density.

3.3 Data

Considering the availability of data, the sample in this paper is the panel data from 30 provinces in China from 2003 to 2020, with a total of 540 observation samples. Tibet, Hong Kong, Macao and Taiwan are not included due to the lack of data. In order to reduce the influence of heteroscedasticity, all variables are in logarithmic form. The data involved in the following variables are from China Statistical Yearbook and China Environmental Statistical Yearbook. The descriptive statistics of each variable are shown in Table 1, and the data processing is implemented in STATA 11 software.

Table 1: Descriptive statistics of variables.

	Obs	Mean	Std.dev	Min	Max
GIP	540	897.2292	776.4135	67.9708	7996.259
GI	540	0.2189	0.0977	0.07678	0.6430
TRADE	540	0.3097	0.3815	0.0076	1.8432
RM	540	3373.079	2087.735	200	14190
PD	540	449.0474	665.6252	7.3931	3949.206
TF	540	0.0147	0.0113	0.0018	0.0741

4 EMPIRICAL RESULTS AND DISCUSSION

4.1 Full Sample Analysis

To study the impact of GIP on ISU, this paper estimates the regression model shown in Equation (1), and the regression results are reflected in Table 2. From columns (1), (2) to (3), we gradually add control variables, and the regression results show that the coefficient of GIP is always significantly negative at the 1% level, which indicates that GIP significantly inhibits the ISU. In conclusion, GIP has a comprehensive inhibitory effect on ISU of China.

In-depth investigation of its reasons, we summarize the following two points. First, although the input of GIP has been continuously increased, the growth of GIP in some regions has been slow or even fallen after 2008. Overall, the total amount of GIP in China is small, so it has not played a vital role in promoting the ISU. Second, with the economic development, some regions put economic benefits first and put most GIP into high energy consumption and high pollution enterprises, which will bring GDP and tax revenue in the short term. This will not only inhibit the ISU, but also may cause environmental pollution.

Table 2: Full sample regression.

	(1)	(2)	(3)
GIP	-0.005*** (-2.60)	-0.006*** (-3.27)	-0.006*** (-3.18)
GI	0.002 (0.26)	0.002 (-0.39)	-0.003 (-0.51)
TRADE		0.006*** (3.08)	0.006*** (2.75)
RM		0.022*** (4.83)	0.020*** (3.97)
PD			0.0009 (0.07)
TF			0.004 (1.07)
R^2	0.8631	0.8713	0.8716
N	540	540	540
cons	0.831*** (56.22)	0.672*** 17.73	0.701*** 8.85
Year effects	yes	yes	yes
Province effects	yes	yes	yes

Notes: *** p < 0.01, ** p < 0.05, and * p < 0.1.

4.2 Heterogeneity Test

In order to test the impact of heterogeneity, we conducted the test again from the two aspects of time and space, and the regression results are shown in Table 3. Considering the slowdown of economic growth in China's economic development after the 2008 financial crisis, we divided the full sample into two sub-samples from 2003-2008 and 2009-2020 for regression based on the 2008 financial crisis. Column (1) lists the regression results of the data from 2003 to 2008. Column (2) shows the regression data results from 2009 to 2020. The results show that the GIP coefficient from 2003 to 2008 is not significant, and the GIP coefficient from 2009 to 2020 is negative at the significance level of 0.5%. This reveals that GIP has a significant negative impact on the ISU after the financial crisis. After the financial crisis, in order to deal with the negative impact of the financial crisis and change the situation of economic downturn, the Chinese government put GIP into low-end industries to satisfy the demand of economic development and improve economic benefits, thus showing a significant inhibitory effect.

In order to study the impact of GIP on industrial structure in different regions, we divided the whole sample into three sub-samples: eastern, central and western region. Column (3), (4) and (5) in Table 3 show the impact of GIP on ISU in eastern region, central region and western region, respectively. The results reflect that the coefficient of GIP in the eastern region is significantly negative, the coefficient of GIP in the central region is insignificant, and the coefficient of GIP in the western region is significantly positive. In general, GIP mainly inhibits the ISU in the eastern region, has no significant impact on the central region, and significantly promotes the ISU in the western region. This is because the level of ISU in the eastern region is relatively high, whereas the total amount of GIP is insufficient and the investment efficiency is not high, which cannot satisfy the needs of industrial optimization in the eastern region. However, the industrial structure of western China is relatively backward and the level of economic development is not high, so the driving effect of GIP on the ISU is more obvious.

Table 3: Heterogeneity analysis.

	(1)	(2)	(3)	(4)	(5)
GIP	0.005 (0.96)	-0.005** (-2.18)	-0.004* (-1.66)	0.002 (0.50)	0.016*** (-4.12)
GI	-0.046*** (-3.50)	0.002 (0.28)	0.016 (1.56)	-0.036** (-2.34)	-0.005 (-0.48)
TRADE	0.006 (0.83)	0.006** (2.38)	0.016** (2.35)	0.011** (2.11)	-0.001 (-0.19)
RM	0.008 (0.90)	0.020** (2.52)	0.035*** (5.49)	0.033** (-2.08)	-0.010 (-1.02)
PD	-0.020 (-0.53)	-0.031 (-1.37)	0.029 (1.58)	0.182*** (3.65)	-0.111*** (-3.49)
TF	-0.006 (-0.80)	0.002 (0.35)	-0.009 (-1.15)	0.015** (-1.98)	0.009 (1.50)
R^2	0.5205	0.8470	0.9143	0.9275	0.8682
N	180	360	198	144	198
cons	0.724*** (3.43)	0.898*** (6.62)	0.423*** (3.33)	-0.848 (-0.34)	1.464*** (9.15)
Year effects	yes	yes	yes	yes	yes
Province effects	yes	yes	yes	yes	yes

Notes: *** p < 0.01, ** p < 0.05, and * p < 0.1.

We further test the internal impact of GIP on industrial structure and examine the different impacts of GIP on primary industry, secondary industry and tertiary industry. Column (1), column (2) and column

(3) in Table 4 respectively show the impact of GIP on primary, secondary and tertiary industries. As can be seen in Table 4, GIP has a significantly positive impact on the secondary industry, whereas it has a significant inhibitory effect on the primary and tertiary industries. The secondary industry is mostly low-end industry with high energy consumption and emission, while the tertiary industry is mostly high-tech industry and service industry. Local governments choose to invest GIP in the secondary industry in the cause of obtaining short-term economic benefits. This proves once again that GIP can inhibit the ISU because it hinders the development of the tertiary industry.

Table 4: Industrial heterogeneity.

	(1)	(2)	(3)
GIP	-0.034* (-1.91)	0.076*** (7.16)	-0.062*** (-6.99)
GI	0.506*** (8.20)	-0.163*** (-4.47)	0.064** (2.12)
TRADE	-0.077*** (-3.61)	0.048*** (3.79)	0.00004 (0.00)
RM	0.134*** (2.64)	0.193*** (6.43)	-0.013 (0.52)
PD	-1.600*** (-12.70)	-0.350*** (-4.69)	-0.043 (-0.70)
TF	-0.010 (-0.25)	0.072*** (3.16)	0.010 (0.55)
R^2	0.7799	0.7075	0.8222
N	540	540	540
cons	6.501*** (8.17)	-0.651 (-1.39)	-0.133 (-0.34)
Year effects	yes	yes	yes
Province effects	yes	yes	yes

Notes: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

4.3 Robustness Test

In order to verify the robustness of the above conclusions, this paper chooses to test the explanatory variables with one-period lag and two-period lag respectively. Column (1) reveals the results of one period lag, and column (2) reveals the results of two periods lag. The regression results are reflected in Table 5, and the coefficients of the core variables are all significantly negative, consistent with the previous results, indicating that the inhibitory effect of GIP on the ISU is sustainable. At the same time, endogeneity problems may arise due to omitted variables and reverse causality. For example, there may be some factors that are difficult to quantify that affect the ISU. Therefore, this paper adopts the instrumental variable method for further testing. We choose the lagged one period of GIP as its own instrumental variable. The regression results in column (3) of Table 5 reveal that the coefficient of the core explanatory variable is still significantly negative, indicating that GIP still has an inhibitory effect on ISU. Therefore, after overcoming the endogeneity problem, the core results are robust. Combining the robustness analysis results of the above two different methods shows that the core conclusion of this paper is robust.

Table 5: Robustness test.

	(1)	(2)	(3)
GIP	-0.004** (-2.39)	-0.006*** (-3.01)	-0.006** (-1.97)
GI	-0.002 (-0.27)	0.001 (0.15)	0.0006 (0.08)
TRADE	0.005** (2.10)	0.005** (2.17)	0.007*** (3.42)
RM	0.016*** (3.03)	0.011** (2.21)	0.020*** (3.17)
PD	0.006 (-0.49)	-0.015 (-1.15)	-0.0003 (-0.02)
TF	0.010** (2.33)	0.014*** (3.52)	0.004 (0.89)
R^2	0.8729	0.8702	0.9590
N	510	480	510
cons	0.783*** (9.59)	0.918*** (10.86)	0.881*** (5.83)
Year effects	yes	yes	yes
Province effects	yes	yes	yes

Notes: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

5 CONCLUSION AND ENLIGHTENMENT

Based on China's provincial panel data from 2003 to 2020, this paper empirically tests the influence of GIP on ISU, and the main conclusions are as follows. First, GIP has a inhibitory effects on ISU, which still supports this result after robustness check. Second, the impact of GIP on ISU has the characteristics of spatial and temporal heterogeneity. The regional results show that GIP has a different impact on the ISU in different regions of China. Specifically, GIP in the eastern region has a significant inhibiting effect, and the positive effect of GIP in the western region is significant, while the positive effect of GIP in the central region is not obvious. Secondly, taking the 2008 financial crisis as the time demarcating point, GIP has no significant influence on the industrial structure adjustment before 2008, but has a significant inhibition effect on the ISU after the financial crisis. Third, GIP will inhibit the ISU by hindering the development of tertiary industry.

On the basis of the foregoing, the policy implications of this paper are shown below. Firstly, the government should increase investment in GIP to meet the needs of ISU and encourage high-quality economic development. Secondly, I attach importance to giving full play to the leading role of the government to clarify the direction of GIP and not simply pursue short-term economic benefits while ignoring the long-term ecological benefits. It is recommended to guide GIP from the root to the inflow of energy-saving and environmental protection industries, to promote the development of green industries and to a certain extent to curb the development of high energy-consuming and high-polluting traditional enterprises. Meanwhile, government should encourage and support policies to force enterprises to "green" transformation and achieve industrial structure optimization. Thirdly, the economic level of each region in China varies and the regional development is unbalanced, so policy makers should adopt differentiated policies for different regions. Specifically, the eastern region has a higher level of economic development and the inhibitory effect of GIP on ISU is significant, so it is crucial to increase the investment in GIP to make it compatible with the higher level of industrial upgrading. Although the western region of China has improved its economic level since the implementation of the western development strategy, its economic development level still is much lower compared with that of the east and central regions due to its weak economic foundation. The western region should improve the endogenous power to pull the GIP into the development of tertiary industry so as to promote the transformation and optimization of industrial structure.

REFERENCES

Guo W, Wang W. Financial agglomeration, regional housing prices and industrial structure upgrading: Two − Wheel Drive or Two − Way Suppression? [J]. Journal of Capital University of Economics and Business, 2021, 23(1): 24-36.

Lan Q, Chen C. Does new-type urbanization promote the upgrading of industrial structure? [J]. Journal of Finance and Economics, 2013, (39):57-71.

Liu C. Study on the action mechanism of population aging affecting industrial structure upgrading [J]. The World of Survey and Research, 2021, (9):39-47.

Lv T, Zhou S. China's industrial structure upgrading and economic growth mode transformation [J]. Journal of Management World, 1999, (1):113-125.

Shi D, Shi X. Green finance and high-quality economic development: Mechanism, characteristics and empirical study [J]. Statistical Research, 2022, 39(1):32-48.

Wang H, Hou J. The impact of heterogeneous environmental regulatory tools on green investment of industrial enterprises. Financial Development Review, 2021, (8):17-30.

Wang L, Zhao W. Research on financial development and upgrading of Industrial structure of China [J]. Research on Financial and Economic Issues, 2015, (1):23-29.

Xie Y, Zou D. The impact of the market-incentive environmental regulation on enterprises' green investment: An empirical study of high-polluting listed companies of A-shares market. Journal of Yunnan Normal University (Humanities and Social Sciences Edition), 2021, 53(6): 76-83.

Yang C. Impact of carbon trading system on green investment: Based on panel data of Shenzhen listed enterprises [J]. Management and Administration, 2022: 1-11[2022-10-04].

Zhao L, Wang X. Can corporate green investment and green expenses improve operating performance? An empirical analysis based on EBM and panel tobit model [J]. Journal of Beijing Institute of Technology (Social Sciences Edition), 2022, 24(3):29-42.

Zhou C, Tian F, Zhou T. Green finance and high-quality development: Mechanism and effects [J/OL]. Journal of Chongqing University (Social Science Edition):1-13.