The Interaction between Green Investment, Technological Innovation and Manufacturing Upgrading

Rongping Li[1], Sai Wang[2,*]

School of Economics and Management, Hebei University of Science and Technology, Shijiazhuang050018, China

Email:[1]First author:1256108972@qq.com;
[2,*]Second author and corresponding author:wangsai98516@163.com

Abstract. To clarify the relationship between green investment, technological innovation and manufacturing upgrading, a panel vector autoregressive (PVAR) model is constructed based on panel data of 31 provinces and cities in mainland China from 2008 to 2020, and the relationship between the three is explored based on the results of GMM estimation and impulse response function. The results show that green investment and technological innovation significantly promote the manufacturing upgrading, with the influence of technological innovation on the manufacturing upgrading greater than that of green investment on manufacturing industry; green investment and manufacturing industry promoting technological innovation; technological innovation has no significant effect on green investment.

Keywords: green investment; technological innovation; manufacturing upgrading; panel vector autoregression

1 Introduction

The "Made in China 2025" issued by the State Council clearly points out that China should build an efficient, clean, low-carbon and recycling green manufacturing system, so green development is the only way to transform and upgrade China's manufacturing industry. China is a large manufacturing country, and traditional manufacturing enterprises are still facing serious problems of high energy consumption, high emissions and high pollution. Actively promoting the green and low-carbon transformation of the manufacturing industry and accelerating the realization of green and low-carbon development and economic growth is an important issue that needs to be solved urgently at present.

According to Porter's hypothesis, environmental regulation can promote technological innovation and bring economic benefits to compensate for the costs of environmental regulation[1]. Lanjouw and Mody[2] confirmed the Porter hypothesis that investment can promote technological innovation. Lee[3] believed that environmental investment promotes corporate technological innovation. Zhang Yueting et al[4] found that environmental protection investment has a positive effect on R&D investment. Malicky

A. Rauf et al. (eds.), *Proceedings of the 3rd International Conference on Management Science and Software Engineering (ICMSSE 2023)*, Atlantis Highlights in Engineering 20,
https://doi.org/10.2991/978-94-6463-262-0_55

and Weber[5] found that there is a very close link between environmental investment, economic growth and industrial structure. Eyraud [6] found that investment in environmental protection helps to improve the environment and adjust the industrial structure. Wang Xueyi and Tan Zheng [7] found that technological innovation has a positive contribution to industrial structure upgrading. Wang Lifang, Xu Jiuxiang[8] pointed out that the current independent innovation capability of China's manufacturing industry is not strong.

The existing studies mainly focus on the impact of green finance to promote economic and environmental benefits, but there is less research on the interaction between green investment, technological innovation and manufacturing upgrading, therefore, this paper constructs PVAR model for empirical analysis based on the panel data of 31 provinces and municipalities in China from 2008 to 2020 to explore the relationship between green investment, technological innovation and manufacturing upgrading.

2 Study Design and Model Construction

2.1 Model Construction

The panel vector autoregressive model was proposed by Holtz-Eakin et al [9], which follows the advantages of the vector autoregressive (VAR) model. This paper divided the manufacturing upgrading into rationalization and advanced manufacturing, and incorporate both of them into the research framework together with green investment and technological innovation, and construct the PVAR model.

2.2 Variable Selection and Data Description

The transformation and upgrading of the manufacturing industry in this paper adopts the degree of advanced manufacturing technology (MAI) to indicate, drawing on the research methods of Fu Yuanhai [10], according to the level of technology, the manufacturing industry is divided into high-end manufacturing, middle-end manufacturing and low-end manufacturing, the advanced manufacturing structure is manifested as low-end manufacturing to high-end manufacturing, so this paper selects the ratio of high-end manufacturing output value and mid-end manufacturing output value to represent the transformation and upgrading of manufacturing industry. This paper uses the measurement method of Sun Zhiyu et al [11] to measure the level of green investment by the proportion of environmental protection expenditure to fiscal expenditure and the amount of investment in industrial pollution control. And, this paper uses the measurement method of Shi [12] to measure the level of technological innovation with the ratio of effective invention patents to the number of patent applications of industrial enterprises and the ratio of R&D expenditure investment to GDP.

The original data of manufacturing transformation and upgrading and green investment in this paper are obtained from the China Statistical Yearbook, the statistical yearbooks of each province and the China Industrial Statistical Year-book. The study is

determined for the period of 2008-2020, and 31 provinces and cities in China (excluding Hong Kong, Macao and Taiwan) are selected as the research samples. For missing data, linear interpolate and take are values for all data.

3 Empirical Evidence and Analysis of Results

3.1 Test of Steady of Panel Data

In this paper, LLC test and Fisher-ADF test were used to test the stationarity of the sequence, and the test results are shown in Table 1. As can be seen from the table, the technological innovation TI passed the LLC and Fisher-ADF test, while the manufacturing rationalization MRI and the Green Investment GI failed the test. Since some variables are non-stationary, the first-order difference is applied for all variables. The sequence dlnGI, dlnTI and dlnMAI were obtained after the variable difference. All three variables passed the test, indicating that subsequent analysis could be conducted.The specific results are shown in Table 1.

Table 1. Panel data unit root test results

Variable	LLC	Fisher-ADF	Steady	Variable	LLC	Fisher-ADF	Steady
lnGI	-3.02***	0.61	N	dlnGI	-8.37***	-6.23***	Y
lnTI	-13.90***	-3.81***	Y	dlnTI	-26.50***	-18.00***	Y
lnMAI	-4.45***	1.54	N	dlnMAI	-10.11***	-7.27***	Y

Note: "Y" in the table indicates that the sequence is stable, and "N" means that the sequence is unstable

3.2 Selection of Model Lag Order and GMM Estimation

In this paper, the optimal lag orders of the variables in the model are determined based on the AIC, BIC and HQIC criteria. The results both show that the optimal lag order of the variables is order 3. Therefore, this paper determines that the optimal lag order is order 3.

After determining the optimal lag order is determined, the generalized moment estimation method (GMM) is used to test the relationship between variables. The GMM estimation results are shown in Table 2. According to Table 2, the rationalization of manufacturing industry and technological innovation do not have a positive promoting effect on green in-vestment; advanced manufacturing industry has a significant positive effect on green investment. Manufacturing rationalization does not have a facilitating effect on technological innovation; green investment and advanced manufacturing have a significant positive effect on technological innovation. Technological innovation and green investment have a significant promoting effect on manufacturing rationalization;

and manufacturing advanced has no promoting effect on manufacturing rationalization. And green investment has a significant promoting effect on advanced manufacturing.

Table 2. Results of the GMM estimation for the PVAR model

Vari-able	L.lnGI	L.lnTI	L.lnMAI	L2.lnGI	L2.lnTI	L2.lnMAI	L3.lnGI	L3.lnTI	L3.lnMAI
lnGI	-0.22***	-0.2***	0.10	-0.01	-0.20**	0.30**	-0.02	-0.05	0.3**
lnTI	-0.1	-0.07	0.09	0.09***	-0.05	0.15**	0.014	-0.08**	0.20**
lnMAI	0.04	0.08***	-0.46***	0.06	0.08**	-0.31***	0.11**	0.04**	-0.28**

Note: ** and *** indicate p<5% and p<1%, respectively.

3.3 Impulse Response Function Analysis

The impulse response function reflects the impact on other variables when a variable in the PVAR model is subject to an exogenous shock. In this study, the shocks are set to 10 periods, and the impulse response analysis of the model is conducted through 200 Monte Carlo simulations. The impulse responses of green investment, technological innovation and rationalization of manufacturing industry and advanced manufacturing industry are shown in Figure 1, and it can be seen that the impulse responses among the variables show a convergence trend with good effects.

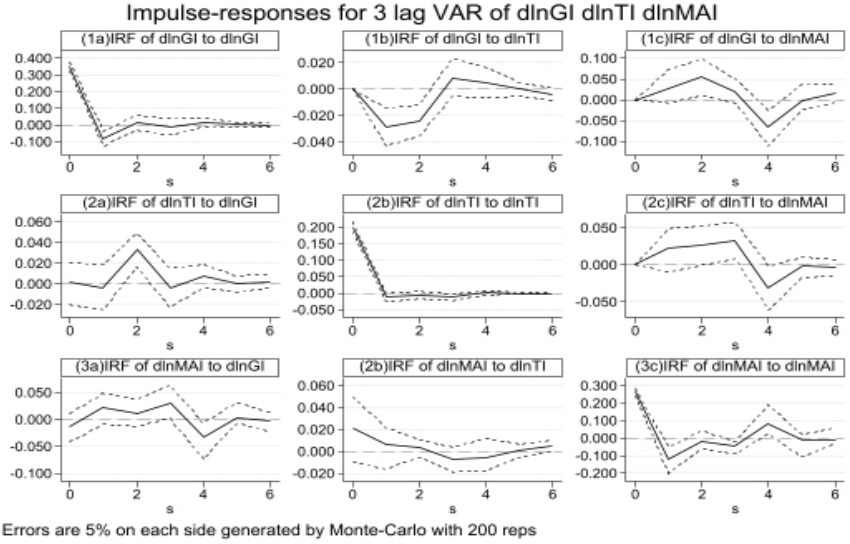

Fig. 1. The response result diagram of the pulse ring

The impulse response function reflects the effect on the others when one variable receives an exogenous shock. In this paper, the pulse response of green investment, technological innovation, and manufacturing upgrading are shown in Figure 1. As can be seen from 1a, 2b, 3c, 4,2a and 3a in Figure 1, when green investment, technological innovation, manufacturing rationalization and manufacturing upgrading are impacted by themselves, and the advanced manufacturing industry is impacted by manufacturing rationalization and technological innovation, they all respond positively and reach the maximum in the current period. From 1b, 2c, 2d, 3d can see, can be seen when the manufacturing rationalization by manufacturing advanced impact, technology innovation by manufacturing rationalization, green investment by the impact of manufacturing rationalization and technological innovation, have negative response, reached the maximum negative response in 1, after the negative response gradually reduced.1c, 4c, 3b, 4b, 4a, 1d, it can be seen that when the technology innovation by the manufacturing senior and green investment, manufacturing rationalization respectively by the impact of technological innovation and green investment, green investment by the impact of manufacturing, manufacturing senior by the impact of green investment, have positive response, in 1 positive response maximum, after gradually reduced.

4 Conclusions

Based on provincial panel data from 2008 to 2020, this paper explores the dynamic relationship between green investment, technological innovation and manufacturing upgrading from two dimensions of manufacturing rationalization and advancedization, and draws the following conclusions:

Firstly, green investment and technological innovation have a significant positive impact on the manufacturing upgrading. The impact of manufacturing upgrading on technological innovation responds quickly and faster, reaching the maximum positive response in the current period. It can be seen that it is reasonable and effective to promote the manufacturing upgrading through green investment and technological innovation. Secondly, green investment and manufacturing upgrading have significantly promoted technological innovation. Between them, technological innovation responds faster to the impact of manufacturing upgrading, and in the long run, the promotion of technological innovation by manufacturing upgrading is more durable. Thirdly, according to the GMM estimated results, although the impact of manufacturing upgrading on green investment is significant from the lag period 2, the impact coefficient shows an increasing trend, green investment promotes the development of manufacturing upgrading, and manufacturing upgrading also provides greater development space for green investment. However, current technological innovation does not promote green investment.

References:

1. Porter, M., Linde CVD. (1995) Towards a new conception of the environment- competitiveness relationship. Journal of Economic Perspective, 9(4): 97-118. 10.1257/jep.9.4.97.

2. Lanjouw, J.O., Mody, A. (1996) Innovation and the international diffusion of environmentally responsive technology. Research Policy, 25(4): 549-571.10.1016/0048-7333(95)00853-5.
3. Lee J., Kim S. (2017) Curvilinear relationship between corporate innovation and environmental sustainability. Sustainability, 9(7):1267-1281. https://doi.org/10.3390/su9071267.
4. Zhang, Y.T., Chen, H.C., He, Z.M. (2022) Environmental regulation, R&D investment, and green technology innovation in China: Based on the PVAR model. Plos, 38(08):129-138+145. https://doi.org/10.1371/journal.pone.0275498.
5. Luiza, B., Lizbeth, N.A. (2004) The underground revolution in the Sino Vallery: acomparison of upgrading in global and national value chmns. Edward ElgarPublishing, 2004:110-127. 10.4337/9781843769743.00012.
6. Eyraud, L., Clements B., Wane A. (2013) Green investment: Trends and determinats. Science Direct，60:852-865. https://doi.org/10.1016/j.enpol.2013.04.039.
7. Wang, X.Y., Tan, Z. (2014) Dynamics of low-carbon technological advances performance: theory and evidence. Scientific Research, 32(5):698-705. 10.3969/j.issn.1003-2053. 2014.05.007.
8. Wang, L.F., Xu, J.X. (2022) Countermeasures and suggestions to promote the transformation and upgrading of China's manufacturing industry. Guangdong Science and Technology,31(11):31-34.
9. HOLTZ-EAKIN, D., NEWEY, W. ROSEN, H.S. (1988) Estimating vector autoregressions with panel data. Econometrica, 56(6):1371-1395. https://doi.org/10.2307/1913103.
10. Fu, W. Y., Li, Y., Zhao, J.F. (2020) How does AI affect the optimization and upgrading of regional manufacturing industries?--Studies based on the double mediation effect. Reform of The Economic System, (04):187-193.
11. Sun, Z. Y. , Liu, S.J.(2023) Green investment, industrial restructuring and high-quality economic development. Statistical Theory and Practice, 2023(02): 27-33.10.13999/j.cnki.tjllysj.2023.02.004.
12. Shi, L. L., Zhao, J. (2018) Environmental regulation, technological innovation and industrial structure upgrading. Management of Research and Development, 39(1):119-125.10.19571/j.cnki.1000-2995.2018.01.013.