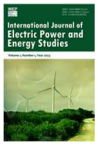
WEP Warwick Evans Publishing

International Journal of Electric Power and Energy Studies

ISSN: 3006-2004 (Print), ISSN: 3006-0826 (Online) | Volume 3, Number 3, Year 2025
DOI: https://doi.org/10.62051/ijepes.v3n3.02
Journal homepage: https://wepub.org/index.php/IJEPES/index



Import Trade of Mineral Resources Industry on Green Total Factor Productivity the Influence of the Study

Ningning Liu

Yunnan University of Finance and Economics, China

ABSTRACT

To promote the green transformation and upgrading of the mineral resources industry under the background of "double-carbon", we should pay attention to the green total factor productivity (GTFP) to measure the industrial production efficiency and environmental impact. With the acceleration of globalization, import has become an effective way to improve the green total factor productivity (GTFP) of the mineral resources industry. This paper aims to explore the influence of import trade in mineral resources industry on green total factor productivity (GTFP), and analyze the mechanism of scale, structure and efficiency of import trade on GTFP by constructing econometric model. It is found that the moderate import trade of mineral resources can promote the technological progress and the introduction of management experience, so as to improve the GTFP of the mineral resources industry. However, excessive reliance on imports may lead to decreased domestic industrial competitiveness and have a negative impact on GTFP. Therefore, this paper proposes a series of policy suggestions, aiming to balance the relationship between the mineral resources import trade and the sustainable development of domestic industry.

KEYWORDS

Mineral Resources Industry; Import Trade; Green Total Factor Productivity; Sustainable Development.

1. INTRODUCTION

Mineral resources are the important material basis for the survival of human society, the source of the manufacturing industry chain and supply chain, and the strategic resource and important guarantee for national security and economic development. In the early 21st century, more than 95% of the energy sources, more than 80% of the industrial raw materials and more than 70% of the agricultural production materials used in China came from mineral resources. In 2022, mineral resources will directly support 33.5 trillion of downstream industrial manufacturing and 8.3 trillion of construction industry, which account for about 35% of China's GDP.

The party's 20th report stressed that "we must strengthen security capacity building in key areas to ensure the security of food, energy and resources, and important industrial and supply chains" and "we must strengthen strategic planning and make early adjustments to ensure the security of supply."The Central Economic Work Conference held at the beginning of 2023 also clearly proposed that "we should strengthen the domestic exploration and development of important energy and mineral resources and increase the storage and production". At present, the CPC Central Committee attaches great importance to the safety of the mineral resources industry, and continues to increase policy support, with unprecedented attention and support. In recent years, with the rapid development of China's economy and industrialization process, the demand for mineral products in the domestic market is also growing, especially in the fields of infrastructure construction, new energy

development, high-end equipment manufacturing and other fields, the demand for mineral resources will further increase. At the same time, the rapid development of mineral resources industry leads to excessive resource consumption, excessive carbon emissions, and huge resource and environmental costs. In 2019, the operating revenue of China's mineral resources industry accounted for 25.28% of industrial revenue, energy consumption for 43.27% of industrial revenue, and carbon dioxide emissions for 33.87% of industrial revenue, as shown in Table 1. The mineral resources industry has become an industry with high energy consumption and high emission. This extensive development mode has reduced the resource reserves and the efficiency of resource utilization, and threatened the ecological environment.

Therefore, the green transformation and upgrading of the mineral resources industry should be promoted under the background of "double-carbon", and the green total factor productivity (GTFP), as a comprehensive index to measure the industrial production efficiency and environmental impact, has attracted more and more attention. With the acceleration of globalization, the import trade of mineral resources industry is increasingly frequent, and import has also become an effective way to improve the green total factor productivity (GTFP) of mineral resources industry. Import can introduce high-end technical products, rapidly improve the level of production technology, expand the source of mineral resources in the region, bulk mineral raw materials that have an important impact on economic development, and a large number of strategic minerals have a relatively high dependence on import. Under the new development pattern of "double cycle" and the strategic goal of "double carbon", the import of mineral products will help to improve the green total factor productivity of the mineral resources industry, improve the security of resources, and boost the green transformation and upgrading of the mineral resources industry.

The world has entered a new period of turbulence and change. It is undergoing major adjustments, differentiation and restructuring, and uncertain, unstable and unpredictable factors are on the rise. Promoting high-quality development of the mining industry and ensuring the safe and stable supply of mineral resources is of great significance to the complex international situation. Based on the impact of import trade of mineral resources industry on GTFP in the new period of China's economic development, this paper expounds the high-quality development path of mineral resources industry in the new stage, which can provide theoretical basis and support for the formulation of relevant policies to improve the green total factor productivity of mineral resources industry.

2. LITERATURE REVIEW

2.1. Concept Definition and Variable Measurement

Green total factor productivity (GTFP): In the face of limited resources and increasingly serious environmental pollution, the concept of green development and sustainable development has attracted people's attention. Resources and environment are no longer only endogenous variables affecting economic development, but also become a rigid constraint restricting the quality of economic development. Compared with the total factor productivity of only expected output, the green total factor productivity, which includes unexpected output such as pollutant emissions in the index system, is more comprehensive and objective (Jiang Rui, 2022). In the early stage, some scholars began to take pollutant emission as an input index to measure the green total factor productivity. The traditional total factor productivity measurement did not include it in the index system, and the measurement results would inevitably be biased. Therefore, many scholars began to resource consumption and environmental pollution as a measure (zhang insipid and TuXiWei, 2022), into the total factor productivity measurement system to evaluate industrial development and economic growth, the resulting total factor productivity is green total factor productivity, also some scholars call it environmental total factor productivity, low carbon economy.

GTFP should consider both the "natural resource consumption" in the input dimension and the unexpected output in the output dimension, so as to better measure the "green" growth of industries and the development level of "higher quality and more efficient" of enterprises (Li Xu and Hou Jie, 2024). In this paper, the connotation definition of green total factor productivity is consistent with this, that is, the overall efficiency of all inputs into the final output, and introduces resource input, environmental pollution and energy consumption.

Import trade in mineral resources Industry (IMPORT): Some scholars study the impact of import trade in China's dairy industry on technological progress, and studies show that dairy import trade between China and a major dairy industry country has promoted the technological progress of dairy industry (Wei Yanjiao and Zhu Jing, 2017). This paper draws on li Peng and Lu Yuyi's definition of the import trade of China's high-tech industrial products and defines the import trade of mineral resources industry as the import quantity of mineral resources industrial products.

2.2. Factors Affecting the Green Total Factor Productivity in the Mineral Resources Industry

GTFP is composed by various factors, so the literature on the influence of GTFP is relatively rich. According to previous scholars, import trade (Qi Shaozhou and Xu Jia, 2018; Shao Jun et al., 2020), foreign investment (Huang Lei and Wu Chuanqing, 2019), industrial structure (Liu Yaobin, 2017), environmental regulation (Ye Rendao, 2017), trade opening (Qian Zhengming and Liu Xiaochen, 2013), energy intensity (Che Lei, 2018), which can affect natural factors, policy factors and economic factors.

2.3. Literature Review

At present, the existing literature has provided us with a solid theoretical basis. This paper has systematically summarized and summarized the relevant literature. Although the existing literature has studied GTFP from different perspectives, the research on GTFP in the mineral resources industry has not been explored in depth. Based on this, this paper sorts out the research achievements of digital economy at home and abroad, combines the definition of mineral resources import trade and green total factor productivity with existing research, constructs indicators, measures import trade and green total factor productivity, and finally uses fixed effect model to analyze the relationship between the two.

3. THEORETICAL PRINCIPLE

In recent years, China's economy has developed continuously, and the demand for mineral products is increasing. With the exhaustion of mineral resources, the development of mineral resources industry is under great pressure. At the same time, the mineral resources industry has the problems of serious resources waste, low efficiency of comprehensive utilization and serious environmental pollution. At present, China's evaluation of the economic growth of mineral resources industry should not be limited to the growth rate, but should consider the benefits of resources and environment. High-quality economic growth is the growth of green total factor productivity. The import of mineral products can introduce high-end technology, reduce resource and energy consumption and pollution emission intensity, and improve GTFP, which is manifested as technology spillover effect.

At the same time, technological progress will promote the continuous transformation of the import structure of the mineral resources industry. If the raw ore is imported, the import cost is low, but the pollution in the production process is large, which is not conducive to the improvement of GTFP level. If there are more imported semi-finished ore products, the cost is higher, but the impact on China's environment is less, which is conducive to the improvement of GTFP, and is manifested as the structural effect. From the perspective of the import situation of mineral resources industry, the

import amount of mining and selection industry accounts for the total import amount of mineral resources industry, and the import structure will have a negative impact on GTFP of mineral resources industry. Under the guidance of the economic theory of resources and environment, the future development direction should not only realize economic growth, but also realize the recycling of resources and reduce environmental pollutants, achieve the unity of economic and ecological benefits, and finally realize the improvement of GTFP. Hypothesis: Import trade of mineral resources industry promotes GTFP.

4. EMPIRICAL ANALYSIS

4.1. Selection of Variables

China 2013-2023 (not including Tibet, Hong Kong, Macao and Taiwan) of mineral resources industry, draw lessons from the practice of Jiang Rui (2022), this paper the mineral resources industry green total factor productivity (GEFP) input index for resource input and energy input, resource input using the industrial output value of mineral resources, energy input energy consumption reflect. The output index of green total factor productivity in mineral resources industry is divided into expected output and unexpected output. Expected output is measured by sales output value, and unexpected output is measured by carbon dioxide emissions.

The measurement indicators of import trade in the mineral resources industry are import openness (IMO) and import structure (MOI). Drawing on the research results, the import openness is calculated by using the following formula:

$$M = \frac{N}{N+P} * 100\% \tag{1}$$

M indicates import openness, N represents import value, and P indicates domestic output value. The import structure of mineral resources industry is measured by the proportion of mining industry in the total import amount of mineral resources industry.

The control variables are resource endowment (RE) and R & D investment (RI). The resource endowment is measured by the proportion of the base reserves of the main minerals in the whole country. The proportion of R & D investment in the operating income reflects the R & D investment of the mineral resources industry in each province.

4.2. Empirical analysis

Establish a fixed-effects model as follows:

$$\ln GTFP_{it} = \beta_1 \ln IMO_{it} + \beta_2 \ln MOI_{it} + \beta_3 \ln RE_{it} + \beta_4 \ln RI_{it} + \delta_{it} \tag{2}$$

It represents the province, the time, and the random interference term.

Then we conducted further analysis of the panel data to determine which model -- used fixed effect or random effect model. We conducted the Hausman test on the data, and the judgment criterion of the Hausman test was to compare the P value in the test results with 0.1. If the P value is less than 0.1, then the fixed effect model is selected, and otherwise, the random effect model is selected.

Table 1. Panel model Hausman-test statistics results

	Coef.
Chi-square test value	**28.44**
P-value	**0**

As shown in Table 1, if the P-value is less than 0.1, the null hypothesis is rejected,

Select the fixed-effect model (FE).

Table 2. Benchmark regression results of the impact of mineral resources import trade on green total factor productivity

Variable	GEFP			
	model (1)	model (2)	model (3)	model (4)
lnIMO	0.0916***	0.0916***	0.0916***	0.0941***
	(4.85)	(4.85)	(4.85)	(5.06)
lnMOI		-0.576***	-0.576***	-0.590***
		(-7.30)	(-7.30)	(-6.97)
lnRE			-0.155***	-0.155***
			(-8.38)	(-8.38)
lnRI				0.047***
				(3.16)
_cons	0.0192***	0.126	0.343	0.627
	(15.64)	(0.36)	(0.37)	(0.65)
N	330	330	330	330
R2	0.932	0.932	0.932	0.932
adj. R2	0.922	0.922	0.922	0.922
F	98.41	95.71	95.71	93.46

According to the analysis of empirical results, the import openness of the mineral resources industry has a positive impact on GTFP. When the import trade of the mineral resources industry increases by 1%, the green total factor productivity will increase by 9.16%; the quality of imported mineral products is relatively good, and the inflow of technology accompanied by import improves the production efficiency of the mineral resources industry. At the same time, with the improvement of mining technology, resource input, slag, tailings and carbon emissions are also reduced, and the comprehensive utilization efficiency of resources is improved, which ultimately promotes the improvement of green total factor productivity. The impact of MOI of import structure of mineral resources industry on green total factor productivity is significantly negative at the 1% level. For every 1% increase of MOI of mineral resources industry, GTFP will decrease by 5.76%. That is, the higher the proportion of mining and selection industry in the import amount of mineral resources industry, the lower the GTFP level of mineral resources industry. However, the effect of the overall

import openness of mineral resources industry is greater than the import structure, so it is proved that the hypothesis H1 is that the import trade of mineral resources industry has a positive impact on GTFP.

5. SUMMARY AND SUGGESTIONS

Improve the level of mineral resources industry GTFP, has a key role to realize the high quality development, this paper by establishing the panel model to analyze the influence of import trade on mineral resources industry GTFP, the direct impact of GTFP import openness present positive effect, the direct influence of mineral resources industry import structure on GTFP present negative.

Therefore, this paper puts forward the following suggestions for the above empirical results:

First, increasing the import of scarce mineral products, high-grade minerals and semi-finished mineral products containing high-end technology can improve China's mineral resources reserves and enhance the resilience and safety of the supply chain. The mining cost of some poor mines in China is high, and the imported concentrate may have a lower cost, so it can improve the efficiency of resource utilization, reduce the carbon emission output in the mining and beneficiation link, and then improve the level of GTFP. Second, optimize the import structure of the mineral resources industry. If the original ore has an absolute price advantage, GTFP will be reduced. If the price has no absolute advantage, semi-finished mineral products containing high-end technology can be imported, and the proportion of import amount of smelting industry will be appropriately increased, which will help the flow of high-end technology into China and improve the level of GTFP.

REFERENCES

[1] Chen Lianfang, Huang Weize. The influence and countermeasures of economic globalization on the development of mineral resources industry in China [J]. China Mining Industry, 2017,26 (04): 21-27.

[2] Li Xu, Hou Jie. Mechanism and effect test of the policy of "integration of two industries" to improve the green total factor productivity of enterprises [J]. Statistics and Decision-making, 2024,40 (17): 178-183.

[3] Gu Wei, Sun Qingqing, Zhang Heping, et al. Supply chain digitalization, total factor productivity and green innovation of enterprises [J]. Modern Management Science, 2024, (04): 138-148.

[4] Zhang insipid, Tu Xiwei. Manufacturing agglomeration, technological progress and total factor energy efficiency of enterprises [J]. Industrial Economy of China, 2022, (07): 103-121.

[5] Zhao Xincheng, Tan Xin. Analysis of the contribution of natural resources to China's economic growth [J]. Exploration of Economic Issues, 2013, (07): 52-56.

[6] Cui Xinghua, Lin Mingyu. How does FDI affect the green total factor productivity of enterprises?-- Empirical analysis based on the Malmquist Luenberger index and the PSM-DID [J]. Economic Management, 2019,41 (03): 38-55.

[7] Shao Anlin, Liu Chang, Yue Xingtong, et al. High-quality development path of China's mineral resources industry in the new period [J]. Metal Mine, 2024, (01): 2-6.

[8] Fan Songmei, Sha Jinghua, Yan Jingjing, Liu Quanwen, Zhou Ping. Risk assessment and Governance of Iron ore resource supply in China [J]. Resource Science, 2018,40 (03): 507-515.

[9] Shao Jun, Shi Zhenkai, Zhu Junming. Import trade and the green transformation development of Chinese cities -- Research based on green total factor productivity [J]. International trade issues, 2020 (12): 51-64.

[10] Wang Wenyu, He Canfei, Ren Zhuoran. Evolution of China's mineral resources trade network [J]. Journal of Natural Resources, 2021,36 (07): 1893-1908.

[11] Jiang Rui. Study on the spatial and temporal evolution effect of green total factor productivity in China's mineral resources industry [D]. Yunnan University of Finance and Economics, 2022.

[12] Li Peng, Lu Yuyi. Research on the Relationship between Import Trade of High-tech Industry and China's High-tech Industry [J]. Jiangsu Business Theory, 2022, (02): 46-49 + 53.

[13] Cui Xinghua, Lin Mingyu. How does FDI affect the green total factor productivity of enterprises?-- Empirical analysis based on the Malmquist Luenberger index and the PSM-DID [J]. Economic Management, 2019,41 (03): 38-55.

[14] Xue Y. Evaluation analysis on industrial green total factor productivity and energy transition policy in resource-based region[J]. Energy & Environment, 2022, 33(3): 419-434.

[15] Li W,Sun H,Tran D K,et al. The impact of environmental regulation on technological innovation of resource-based industries[J]. Sustainability, 2020, 12(17): 6837.

[16] Mohsin M, Zhu Q, Naseem S, Sarfraz M, Ivascu L. Mining industry impact on environmental sustainability, economic growth, social interaction, and public health: An application of semi quantitative mathematical approach[J]. Processes, 2021, 9(6): 972.