

Dear reviewer,

Thank you very much for your time involved in reviewing the manuscript and your very encouraging comments on the merits.

General Comment:

“The article titled as “Carbon effects from intra-product international specialization: evidence from China’s manufacture industries” is very interesting and informative. However, the author (s) must incorporate the following issues to improve the article.”

Response:

We greatly appreciate your clear and detailed feedback and hope that the explanation may fully address all of your concerns. In the following context, we discuss each of your comments individually along with our corresponding responses. To facilitate this discussion, your comments are typed in italic font and then present our responses to the comments.

Comment 1:

“In the abstract please mention explicitly one or couple of policy implications relevant to the study”

Response 1:

We have included the summarized policy recommendations in the abstract. The revision is shown below. Red words are added parts.

Abstract: ^{1,2}

Intra-product international specialization promotes the global diversification of manufacture industries with various carbon intensities. As the emerging topic of global warming, a new constraint of carbon in international trade is imposed to developing countries, such as China. To explore the potential effects of this constraint under the progress of specialization, a new theoretical framework was proposed with a series of empirical tests through detailed panel data built on statistics from 2004-2020 manufacture industries in China. Test results indicated that carbon emission in manufacture was partially induced by specialization and its emission level was determined by the participation of specialization. Industries with various attributes presented heterogeneous performances under the carbon effect. The intra-product international specialization introduces more significant carbon effects on certain industries, such as those with low technique, capital intensive, and medium to high carbon intensive. **Therefore, given the carbon constraint, the high-quality development in the manufacturing industries may be attained in the developing countries, such as China, through the improvement of specialization in the international market, and the incremental foreign investment to high-value-added, low-carbon production sectors. The improvement could be secured by implementing appropriate industrial policy and constraints of energy consumption.** ^{1,2}

Keywords: Carbon effects; Intra-product internaional specialization; Share of vertical specialization(VSS) ^{1,2}

Comment 2:

“On page 3, line 87-96, the author claimed some distinct features or contributions of this study from previous ones. The author must mention references or quote the studies from which this study is significantly different in all three contributions claimed.”

Response 2:

We added a new figure in the introduction section and a new paragraph in literature review section to stress our contributions. The figure summarized prominent articles and their core viewpoints related to this topic. The revisions are shown below. Red words are new added.

Topic	Core Viewpoints	Representative literature
The externalities of international specialization		
***damage from *** specialization	These arguments emphasized the spreading pollution brought by the international specialization, and concurred the pollution heaven hypothesis as well as the "race to the bottom" theory.	Taylor, 2005[2]; Abay et al., 2010[3]
***benefits of *** specialization	These arguments emphasized the diffusion of creative and environmental-friendly technologies.	Cole, 2005[4]; Azzam, 2012[5]
***complex process	This perspective highlighted the potential presence of an Environmental Kuznets Curve (EKC) and suggested that the impact of the international division of labor on ecological degradation varies according to spatial and temporal factors.	Leblond et al., 2016[6]; Faudet and Schafers, 2005[7]; Mansoor et al., 2015[8]; Buzar et al., 2011[9]; Abdullah, 2023[10]
Effects of international specialization on environment and its quantification		
***ACT model	The model offers a practical approach for examining the three environmental effects and evaluating the influences of international trade on the environment. Many studies have adopted this model or its improved counterpart.	Grossman and Krueger, 1993[11]; Antweiler, Copeland and Taylor, 2001[12]; Hatchuel and Ketenci, 2016[13]; Hajami and Jamali, 2016[14]; Paggio et al., 2017[15]
***Input-output *** model (IO)	Input-output models, which are derived from the theory of equilibrium and reproduction, are able to examine the connection between sectors in terms of supply and demand. Their theoretic fundaments provide broad applications beyond economic systems.	Detzenbacher and Mullooly, 2007[16]; Wang et al., 2009[17]; Su and Ang, 2013[18]; Duan and Jiao, 2017[19]
***Simultaneous *** equations model *** (SEM)	Simultaneous equations model is created by incorporating the principles of trade and growth, as well as the environmental Kuznets curve, to expand the analysis of the three environmental effects.	Dean, 2002[20]; Azzam and Ihsan, 2020[21]; Shahzade et al., 2023[22]
Action mechanism of international specialization on environment pollution		
***International *** trading perspective	The previous research discussed three primary viewpoints. The first perspective involved examining how the division of labor affected the environment by comparing trade patterns across various countries. The second perspective aimed to understand the role of trade policy in the three effects and explores their mechanisms. The third perspective delved deeper into analyzing the mechanisms behind the individual effects.	Detzenbacher et al., 2020[23]; Dean and Lovely, 2010[24]; Wang et al., 2020[25]; Su and Thomson, 2016[26]; Mallouk and Khrouj, 2022[27]; Abdullah and Ergon, 2023[28]
***Industrial perspective	Previous research has been categorized into three primary viewpoints: firstly, examining the distinct operational mechanisms of various industries from an industry standpoint; secondly, investigating the impact of foreign investment on environmental pollution from an asset perspective; and thirdly, exploring the connection between the international division of labor within companies and environmental pollution from a micro-level standpoint.	Huang and Wu, 2022[29]; Narasimha et al., 2023[30]; Dheka et al., 2023[31]; Abdullah and Belar, 2023[32]

5.4 Heterogeneity Test

Previous studies focused on verifying the correlation between the level of intra-product division of labor and carbon emissions. In this paper, we further looked into the data related to China's manufacturing industry, and tried to identify how division level of a given type of good related to its carbon emission during production. In this case, heterogeneity tests were required across various types of goods and their international intra-product division of labor. * * *

5.4.1 Heterogeneity in technique complexity

This study separated China's manufacturing industry into low-tech (low_Tech), intermediate-tech (intermediate_Serve), and high-tech (high_Serve) industries based on the industry's R&D input-output ratio, according to the industrial division criterion recommended by the OECD in 1986. The results of the groups' regressions are given in the column (1) of table 7, where the coefficients of VSS present an inverse "V" shape with technique advance. One possible explanation is that the capabilities of technique absorbing and attributes of various industries result in different productivity improvement benefiting from the intra-product international specialization. The participation of technique intensive industries in international specialization could further improve their productivity with less carbon emission. Industries with intensive high techniques would have more fierce international competition, which promotes enterprises in these industries to elevate their productivity and upgrade their techniques. The upgradation of these enterprises could be achieved by pure technique improvement and industrial transformation, which further reduces the carbon emission. Compared to enterprises in high technique industry, those in low or intermediate technique industries, especially those in processing trade, are weakly positioned in global value chain. The participation of those enterprises in international specialization may not contribute to their productivity and carbon emission reduction due to their limited capabilities of research and development. With great sensitive to the cost of manufacture and trade, the enterprises in low technique industry tend to invest more in manufacture to enhance their efficiency of production, ignoring the building of carbon emission reduction, resulting in the unsatisfying effect of carbon emission. * * *

5.4.2 Heterogeneity in capital intensity

Comment 3:

"Please provide a table of recent literature relevant to the topic in chronological order"

Response 3:

We added a new figure in the introduction section. The figure summarized prominent articles and their core viewpoints related to this topic. The revisions are shown below. Red words are new added.

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Comment 4:

“The theoretical framework is nicely built”

Response 4:

Thank you for this appreciation.

Comment 5:

“Discussion of main results with contextualization i.e. consistency or contradiction with prior studies is very short. The author (s) needs to expand it.”

Response 5:

According to your comments, we revised the section 5 “Test Results of the Effect of Intra-product International Specialization on Carbon Emission”. The revisions are shown in below. Red words are new added.

5.4 Heterogeneity Test^ω

Previous studies focused on verifying the correlation between the level of intra-product specialization and carbon emissions. In this article, we further looked into the data related to China's manufacturing industry, and tried to identify how division level of a given type of good related to its carbon emission during production. In this case, heterogeneity tests were required across various types of goods and their international intra-product specialization.[†]

5.4.1 Heterogeneity in technique complexity^ω

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5.4.2 Heterogeneity in capital intensity^ω

Similar to the classification in technique complexity, all industries are categorized into three groups according to net balance of fixed assets in each industry that symbolizes the capital intensity. The results are shown in the column (2) of table 7, indicating the capital intensity with a positive adjustment effect on carbon emission under the intra-product international specialization. Since the continuing rising of China's relative proportion of capital factors as well as the fundamental reconstruction of their resource endowments after joining global trade, the structure of China's international intra-product specialization dynamically changed. Different from the labor

Comment 6:

“The policy implications should be drawn from obtained results and should be precisely linked with your study findings”

Response 6:

According to your comments, we revised the policy suggestion section to tightly tie up the suggestions to our findings. The revisions are shown in below. Red words are new added.

6.2 Policy suggestion

(1) Raising the level of the international intraproduct division of labor and accelerating the upgrading process of intra-product trade. In the progress of China's transformation of foreign trade, under the premise of full understanding and giving full access to the current domestic endowment advantages, it is necessary to gradually enhance structure of endowments to achieve dynamic transformation of comparative advantages. Moreover, it is necessary to improve the technology intensity of intermediate good production, thus extending China's intra-product international specialization to a higher level. Furthermore, with the comprehensively consideration of carbon regulation with trade efficiency, the industrial policies on those manufacturing industries with deep participation in the international intra-product division of labor should be reconsidered, in purpose of improving the extensive pattern of economic growth, characterized by blind expansion of production scale, high input, high

consumption, and high pollution, adjust the industrial structure of the high-carbon manufacturing industry, and tried to achieve high-quality development of processing trade under the background of “Carbon Peaking and Carbon Neutrality”.

(2) At present, the manufacture structure of Chinese processing trade, which is mainly composed of foreign-invested enterprises, has begun to adjust. By guiding foreign investment into the production units of low-carbon, high-value-added and technology-intensive industries, not only can China join in the production chain of high-tech and high-value-added at an early stage in the international specialization to obtain greater trade benefits, but also promote the low-carbon composition effect of intra-product international specialization.

(3) China should accelerate the technological innovation and enlarge the investment in research and development of technologies in energy saving and emission reduction. Given the increasing carbon tariffs, Technological change is the key to realize China's carbon target, and China should improve the technique levels in those industries participated in intra-product international specialization, enhance the technique level and added value of their products, and reduce their consumption of raw materials and energy with lower emission in the production of intermediate good. China may achieve the high quality of development by driving the alteration of their primary production units from high carbon to low carbon within intra-product international specialization.

Other Comment :

“i have seen a few grammar mistakes. The authors should proofread the article to avoid grammar and syntax errors.”

Response :

For typos and grammatical mistakes, we have carefully and thoroughly proofread the manuscript to correct these issues.