Digital Economy

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With the development of digital technologies such as the Internet and digital industries such as e-commerce, the digital economy has become a new form of economic and social development, which has brought forth a new perspective for environmental governance, energy conservation, and emission reduction.

Keywords: haze pollution ; digital economy ; industrial structure ; spatial spillover

1. Introduction

The low-cost, high-efficiency digital economy industry has witnessed constant development; as a consequence, many new industries have appeared. The transformation and upgrading of traditional industries have been accelerated, particularly as the Chinese government has been making efforts to coordinate environmental protection and economic development. At the national level, the digital economy is becoming increasingly important for societal development. According to China's Digital Economy Development White Paper [1], the digital economy grew by 15.6% annually to 35.8 trillion yuan in 2019 or 36.2% of the gross domestic product (GDP). Societies worldwide are moving toward rapid optimal allocation and regeneration of resources through the digital industry. This is reflected, for example, in the 'Made in China 2025' strategy and the 'Industrial Internet' in the United States. The influence of emerging industries on environmental governance can be analysed through the identification, selection, filtering, storage, and use of big data.

Whether digital technology can improve environmental pollution is related to whether digitalisation can help reduce both energy consumption and the cost of environmental governance. The previous literature has studied the overall association between economy-wide energy consumption and information and communication technologies (ICTs). Some scholars argue that ICT has reduced the demand for energy through energy efficiency and sectoral changes. Schulte et al. [2] found that in the Organisation for Economic Cooperation and Development (OECD) countries, 'a 1% increase in ICT capital results in a 0.235% reduction in energy demand'. This is not due to a decrease in electricity consumption but a decline in other non-electric energy sources, possibly arising from the direct impact of ICTs and services on electricity and the indirect impact on non-electric energy carriers in other parts of the economy. ICTs can enrich environmental quality through dematerialisation of production, thereby supporting a less resource-intensive and lightweight economy [3][4]. Ren et al. [5] used the provincial data, systematic GMM method, and intermediate effect model of China from 2006 to 2017 to demonstrate that the relationship between Internet development and energy consumption structure has a negative impact. However, some scholars believe that ICT application will increase energy consumption due to the 'rebound effect' [6]; Zhou et al. [7] analysed the carbon emissions at the industry level in China by using the input–output method; the ICT sector can induce a large amount of emissions by requiring carbon-intensive intermediate inputs from non-ICT sectors. In other words, the application of ICT does not significantly improve the environment and may even worsen environmental problems. Some scholars believe that this influence is not good or bad. Noussan and Tagliapietra [8] forecasted the future European scenario and analysed the potential impact of digital technologies such as the Internet of Things on energy consumption and carbon dioxide emissions in the transportation field. The impact on green sustainability depends on user behaviour, economic conditions, transport, and environmental policies.

Information asymmetry is another challenge in environmental governance. It not only increases environmental governance costs and weakens the effectiveness of environmental policies, but it also leads to a lack of regulatory bodies in environmental governance and reduces the public's enthusiasm for environmental governance. In 2016, China launched an ecological and environmental protection big data service platform as part of the Belt and Road Initiative. 'Internet +', big data, remote sensing satellites, and other information technologies provide environmental information support to China and other countries along the initiative. The Internet's openness, interactivity, and real-time nature make public participation in environmental governance both possible and convenient [9]. Moreover, the Internet promotes environmental supervision, management, intelligence, accurate services, and rectifies previous environmental governance deficiencies [10][11]. Zuo et al. [12] made recommendations to adopt IOT technology to dynamically collect real-time product data related to energy consumption to improve energy efficiency and large-scale utilisation of clean energy. Li et al. [13] empirically concluded that digital technology promotes environmental sustainability in Chinese manufacturing.

Simultaneously, the digital economy is reshaping the global value chain. According to the 'smiling curve' theory, high added value is located at both tails of the curve, representing the upstream (pre-production research and development) and downstream (post-production services) of the value chain. Processing and assembly activities are located at the midpoint of the curve, indicating little added value [14]. In the past, China's manufacturing sector embraced economies of

scale for profitability with high volume, low-value production that also created severe air pollution. As the energy factor shifts from the industrial to the service sector, growth in the more energy-efficient sectors will reduce emissions; consequently, the overall economy will be more energy efficient [15][16][17]. Original elements and resources are transferred from industries with low distribution efficiency to technology-intensive industries with high distribution efficiency [18]. Thus, upgrades to the industrial structure would have a substantial impact on pollution.

Additionally, a characteristic of the digital economy is the physical sharing of information. Spatial changes have completely overhauled logistics links, resulting in the emergence of new industries, such as e-commerce, which is witnessing rapid growth due to the high penetration of the Internet and the large numbers of mobile users [19]. E-commerce can improve environmental pollution, as it significantly reduces information search costs and product prices and does a better job of matching. Thus, these supply–demand resources significantly reduce transportation and distribution costs, require less energy consumption, and reduce carbon dioxide emissions compared to in-person shopping [20]. E-commerce can also significantly optimise the corporate structure and management, thereby improving production efficiency [21]. The digital economy changes the smile curve, reconstructs the industrial value chain, and realises green development under the value chain sharing economy.

We find that, first, the existing literature discusses the impact of digitisation on carbon emissions, SO_2 emissions and energy consumption through the use of the Internet, output value proportion of the tertiary industry, and investment in the ICT industry as proxy indicators. It is worth noting that the digital economy has received more and more attention, while little empirical research has been conducted to explore whether the development of the digital economy can improve air pollution in China. Second, previous studies have always carried out regression analysis on ordinary panels or dynamic panels, ignoring the spatial correlation and spatial spillover effect of haze pollution. In reality, the diffusion of haze between different regions will lead to spatial correlation and spatial dependence. In spatial econometrics, neglecting spatial effects may lead to errors in estimation and analysis. In a digital environment, search costs are lower, which increases the potential scope and quality of the search. Digital products are often not competitors; that is, they can be replicated at zero cost. As the cost of transporting digital goods and information approaches zero, the role of geographical distance is also expected to change. Digital technology makes it easier to track behaviour [12], and the digital economy containing the above characteristics undoubtedly brings a new perspective for environmental governance.

2. Haze Pollution Levels, Spatial Spillover Influence, and Impacts of the Digital Economy: Empirical Evidence from China

The findings are as follows: First, both haze pollution and digital economy distribution present significant global positive spatial spillover effects and local characteristics. Second, the digital economy has a positive impact on reducing smog. The development of the digital economy in neighbouring provinces has a significant positive spillover effect on reducing haze pollution in key provinces. The change of energy structure and innovation degree can effectively restrain the aggravation of haze pollution, and the conclusion is still valid in the robustness test using the instrumental variable method and adjusting the spatial matrix. Third, the results of the transmission mechanism show that the development of the digital economy can affect haze pollution by changing the industrial structure, showing the non-linear feature that the influence of haze reduction continues to weaken. Finally, in terms of regional differences, the impact of the digital economy on haze pollution is most significant in eastern China, while not significant in central and western China. The following policy recommendations are put forward.

First of all, the penetration and application of digital technology in environmental governance should be accelerated. We would increase investment in digital technologies; pay attention to the breadth and depth of applications in advanced fields such as the Internet, 5G, artificial intelligence, and big data; promote the circulation and sharing of resources, knowledge, and capital; and promote the improvement of digital economy in environmental governance, such as energy conservation and emission reduction. Second, the transformation and upgrading of industrial structure should be promoted, encouraging enterprises to vigorously develop cutting-edge technologies and promoting the continuous progress of digital industry and digitization of industry. Third, it is necessary to understand further the positive impact of the digital economy on reducing haze pollution in central and western China, indicating that a dynamic and differentiated digital economy strategy should be implemented. Finally, haze reduction policies should take into account spatial spillover and decomposition boundaries of administrative areas.

References

1. China’s Digital Economy Development White Paper. 2020. Available online: http://www.caict.ac.cn/kxyj/qwfb/bps/202007/t20200702_285535.html (accessed on 19 April 2021).
2. Schulte, P.; Welsch, H.; Rexhaeuser, S. ICT and the demand for energy: Evidence from OECD countries. Environ. Resour. Econ. 2016, 63, 119–146.
3. Fuchs, C. The implications of new information and communication technologies for sustainability. Environ. Dev. Sustain. 2008, 10, 291–309.

4. Ishida, H. The effect of ICT development on economic growth and energy consumption in Japan. Telemat. Inform. 2015, 32, 79–88.
5. Ren, S.; Hao, Y.; Xu, L.; Wu, H.; Ba, N. Digitalization and energy: How does internet development affect China's energy consumption? Energy Econ. 2021, 98, 105220.
6. Lange, S.; Pohl, J.; Tilman, S. Digitalization and energy consumption. Does ICT reduce energy demand? Ecol. Econ. 2020, 176, 106760.
7. Zhou, X.; Zhou, D.; Wang, Q.; Su, B. How information and communication technology drives carbon emissions: A sector-level analysis for China. Energy Econ. 2019, 81, 380–392.
8. Noussan, M.; Tagliapietra, S. The effect of digitalization in the energy consumption of passenger transport: An analysis of future scenarios for Europe. J. Clean. Prod. 2020, 258, 120926.
9. Chong, M.; Choy, M. The Social Amplification of haze-related risks on the internet. Health Commun. 2016, 33, 14–21.
10. Granell, C.; Havlik, D.; Schade, S.; Sabeur, Z.; Delaney, C.; Pielorz, J.; Havlik, F.N.; Bodsberg, R.; Berre, A.; Mon, J.L. Future Internet technologies for environmental applications. Environ. Model. Softw. 2016, 78, 1–15.
11. Zhu, J.; Xie, P.; Xuan, P.; Jin, Z.; Yu, P. Renewable Energy Consumption Technology under Energy Internet Environment. In Proceedings of the 2017 IEEE Conference on Energy Internet and Energy System Integration (EI2), Beijing, China, 26–28 November 2017; Available online: http://www.researchgate.net/publication/322351391_Renewable_energy_consumption_technology_under_energy_internet_environment (accessed on 24 March 2021).
12. Zuo, Y.; Tao, F.; Nee, A.Y.C. An internet of things and cloud-based approach for energy consumption evaluation and analysis for a product. Int. J. Comput. Integr. Manuf. 2017, 31, 337–348.
13. Li, Y.; Jing, D.; Li, C. The impact of digital technologies on economic and environmental performance in the context of Industry 4.0: A moderated mediation model. Int. J. Prod. Econ. 2020, 229, 107777.
14. Shin, N.; Kraemer, K.L.; Dedrick, J. Value capture in the global electronics industry: Empirical evidence for the 'smiling curve' concept. Indus. Innov. 2012, 19, 89–107.
15. Li, K.; Lin, B. The non-linear impacts of industrial structure on China's energy intensity. Energy 2014, 69, 258–265.
16. Tian, X.; Chang, M.; Shi, F.; Tanikawa, H. How does industrial structure change impact carbon dioxide emissions? A comparative analysis focusing on nine provincial regions in China. Environ. Sci. Policy 2014, 37, 243–254.
17. Chang, N. Changing industrial structure to reduce carbon dioxide emissions: A Chinese application. J. Clean. Prod. 2015, 103, 40–48.
18. Qin, J.; Liu, Y.; Grosvenor, R. Data Analytics for Energy Consumption of Digital Manufacturing Systems Using Internet of Things Method. In Proceedings of the 2017 13th IEEE Conference on Automation Science and Engineering (CASE 2017), Xi'an, China, 20–23 August 2017; Available online: http://www.researchgate.net/publication/322565613_Data_analytics_for_energy_consumption_of_digital_manufacturing_systems_using_In (accessed on 12 March 2021).
19. Oláh, J.; Kitukutha, N.; Haddad, H.; Pakurár, M.; Máté, D.; Popp, J. Achieving sustainable e-commerce in environmental, social and economic dimensions by taking possible trade-offs. Sustainability 2019, 11, 89.
20. Romm, J. The Internet and the new energy economy. Resour. Conserv. Recycl. 2002, 36, 197–210.
21. Bloom, N.; Sadun, R.; Van Reenen, J. Americans do it better: US multinationals and the productivity miracle. Am. Econ. Rev. 2012, 102, 167–201.