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Brief Report

The Influence and Mechanism of Digital Economy on the Development of the Tourism Service Trade—Analysis of the Mediating Effect of Carbon Emissions under the Background of COP26

Jie Zhang and Yunfeng Shang *

School of Hospitality Administration, Zhejiang Yuexiu University, Shaoxing 312000, China
* Correspondence: 20141075@zyufl.edu.cn

Abstract: This study explores the impact and mechanism of the digital economy on the tourism service trade. We adopted two-way fixed effects and mediating effects models, and conducted empirical studies based on panel data of 30 provinces (municipalities and autonomous regions) in China. The results show that the digital economy can significantly improve the development of the tourism service trade, and has a certain role in carbon emission reduction. This conclusion remains valid after a series of robustness tests and proves that carbon emission per capita plays an intermediary role in this process. The regional heterogeneity analysis shows that the digital economy plays a more significant role in promoting inland regions and regions with a higher tourism resource endowment. These findings are significant for the relevant industries, ecological activists, other stakeholders and the realization of the «Glasgow Climate Pact». The results provide guidelines for the recovery of the tourism service industry in the post-epidemic era, achieving the "double carbon" goal, realizing low-carbon tourism and the control of carbon emissions by countries related to the COP meeting. The guidelines can help to strengthen the development of digital infrastructure and promote digital technology in the tourism service industry, differentiate promotion measures based on geographical location and tourism resource endowment, fully consider the intermediary role of carbon emissions, and develop corresponding low-carbon technologies and innovative green technologies.

Keywords: digital economy; tourism service trade; carbon emissions; post-epidemic era; «Glasgow Climate Pact»

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1. Introduction

With the opening up of China's economy, the continuous improvement in national income levels, and the increasingly prominent position of the services industry in the global economic market [1], the tourism industry is increasingly regarded as an important indicator of the country's level of modernization [2], and an important vector in international economic and trade exchanges. The global economy was severely impacted by the COVID-19 pandemic in 2020, and tourism in most countries almost came to a halt [3]. With the advent of the post-epidemic era and the normalization of epidemic prevention and control measures, how to guide the recovery of the tourism industry has become one of the key points of China's economic growth.

Concurrently, the rapid development of the digital economy, the proposal of the goal of "carbon peaking and carbon neutrality", and the convening of the Glasgow Climate Conference (COP26) have also brought opportunities and challenges to China. A digital economy—seen as the new momentum for economic development in China—can directly impact industry digitization and development. It can also serve as an important "booster" to promote the development of the services trade, improve operational efficiency in all aspects of tourism, shorten transaction times, reduce transaction costs for tourists and at scenic

spots, and drive the development of the global tourism service trade [4]. The digitization of trade modes and trade objects will increasingly become an important feature of the trade in global services. Digital industrialization and industrial digitalization constantly give rise to new forms of services, such as digital tourism and online tourism, that facilitate the tourism services trade; therefore, the digital economy is undoubtedly one of the key factors to promote the development of the tourism industry in the post-COVID-19 era.

Many studies have examined the digital economy. Wang et al. [5] used fixed effect and intermediary effect models to test the influence mechanism of Internet development on economic growth. Their statistical results show that the development of the Internet has contributed significantly to economic growth. In addition, digital technologies may provide further impetus for carbon reduction by replacing the need for emissions-intensive products, and optimizing resource management and decision-making processes through system integration. It may also provide further impetus for carbon emission reduction and enhance carbon emission reduction through effective technological innovation. For example, Saqib [6] studied the economic development of the world's 18 most developed economies and pointed out that renewable energy is an important variable in reducing carbon emissions. A positive technological innovation shock will reduce carbon emissions, while a negative technological innovation shock will increase carbon emissions. As one of the representative achievements of positive technological innovation in recent years, a digital economy is considered an important basis for realizing the dual carbon goal, and it is also an important way for countries around the world to achieve the "Glasgow Climate Convention" and promote the transformation of low-carbon energy.

This paper establishes an empirical model based on Chinese provincial panel data to explore the influence mechanism between them and the intermediary effect. The possible marginal contributions are as follows. First, based on the development level of the digital economy, this paper constructs a model of the impact of China's digital economy on international tourism service trade from a relatively comprehensive perspective, thus expanding existing research. Second, it analyzes the influence mechanism of the digital economy on international tourism, taking advantage of the carbon reduction effect of the digital economy, discusses the mediating role of carbon emission by using the carbon emission reduction effect of the digital economy, and verifies it with empirical analysis to deepen the existing literature. Third, based on geographical location and tourism resource endowment, the study explores the heterogeneity effect of China's digital economy on international tourism. Last, by placing the digital economy, the tourism industry, and carbon emissions in the same framework, a mathematical model is developed for a comparative analysis to verify the relationship between the three.

The main objective of this study is to clarify the specific pathways through which the digital economy enables trade in tourism services and to explore whether carbon emissions play a part in this process. The tourism industry was one of the sectors most seriously impacted by the COVID-19 outbreak; however, given the momentum of the global digital era since the outbreak and the relative importance of tourism in a country's economy, once the outbreak is under control, the tourism industry can play an important role in economic recovery.

Against this background, a study of the impact of the digital economy on the tourism service trade and the mechanism of the intermediary effect of carbon emission reduction is of great significance to optimize the structure of the service trade, promote the high-quality development and high-level opening of the tourism service trade, and make certain contributions to the sustainable development of tourism ecology and the deepening of the goal of "carbon peaking and carbon neutrality". The rest of the paper includes a literature review and theoretical mechanism analysis, model construction, index selection and data sources, empirical test, conclusions, and policy suggestions.

2. Literature Review and Theoretical Mechanism Analysis

2.1. Literature Review

Digital economy refers to a series of economic activities based on digital technology with a digital platform as the main medium supported by digital empowerment infrastructure. Its content not only includes digital transactions but also infrastructure, digital media, and digital goods and services to ensure the normal development of digital transactions. It is an all-round and multi-dimensional economic system [7]. In recent years, the topic of digital economy has attracted extensive attention from scholars all over the world. Mulaydinov [8] has pointed out that a digital economy is a very complex system shaped by human beings; it is a comprehensive system of management, definition, organization and planning—all of which are aimed at ensuring sustainable economic growth and improving human life and living standards. Salamatov et al. [9] discussed the innovation environment required for the development of a digital economy from the perspective of "management ecology". This environment focuses on the security requirements of the environment and economy, and can provide solutions for the sustainable development of an innovation environment. The formulation of new education and social policies and the establishment of business support are also needed to create a talent reserve to ensure the continuous improvement of national competitiveness. Digitization is also changing patterns in various forms of social and economic relations, and the increase in digital penetration has created new challenges and threats for social and economic development [10]. Bukht and Heeks [11] concluded that developing countries need to formulate effective, sustainable, and consistent policies in all sectors to promote the growth of a digital economy and its contribution to social and economic development. Bilozubenko et al. [12] compared the development level of digital economies in European Union (EU) countries. They created a digital economy vector containing 20 index features, compared the digital economy development parameters of EU countries on the basis of a cluster analysis, and finally, provided a solution for bridging the digital economy gap between countries.

Zuo et al. [13] found that in the post-COVID-19 era, a digital economy has a natural technological advantage in that it can give full play to the advantages of a super-large market and potential domestic demand, which could also serve as a powerful booster for China to build a development pattern of domestic and international double circulation with domestic circulation as the main body. Yu and Feng [14] conducted a regional analysis on the differences and influencing factors of the development of China's digital economy. They found that overall regional disparities in digital economy development in China present an expanding trend, and that there is a strong positive correlation between regional and overall disparities in digital economy development. However, differences in the development of a digital economy within a region is opposite to differences for the whole region. In addition, the digital basis is the main reason for regional differences in the development of a digital economy. A regional analysis of digital economy development provides valuable insights for backward regions to catch up with advanced regions and how to close the digital divide between regions. Hu et al. [15] used Python technology to obtain data on urban digital economy development, and verified the acceleration effect of the degree of economic digitization development on industrial structure upgrading. They also explored the synergistic development effect of economic policy tendencies and regional modernization level on the upgrading of industrial structure and the increasing marginal benefit trend of the influence between digital economy and industrial structure.

Against the background of global warming, the carbon reduction effect of the digital economy is also attracting attention. General Secretary Xi Jinping announced at the general debate of the 75th Session of the United Nations General Assembly in September 2020 that "China strives to peak CO_2 emissions by 2030 and achieve carbon neutrality by 2060". At a subsequent summit, Xi went further, saying that "By 2030, China's carbon intensity will be reduced by more than 65 percent from 2005 levels". On 31 October 2021, the 26th Conference of the Parties to the United Nations Framework Convention on Climate Change was officially held in Glasgow, United Kingdom. People from all over the world gathered

in Glasgow, United Kingdom, to participate in the 26th United Nations Climate Change Conference. COP26 is of great significance. Whether the Paris Agreement can be fully and effectively implemented, whether developed countries can fulfill their commitments, and whether they can promote fair and inclusive climate action were the focus of this conference. At a time when it is imminent to deal with global climate change, the world's largest and most important climate-related conference undoubtedly undertook an important mission of coordinating and guiding global climate policies in the coming decades, and carbon emission control would undoubtedly become the key to the conference. It can be seen that the issue of carbon emission reduction has become a hot topic in the world, and academics have also conducted research on carbon emissions from various aspects.

We also found relevant studies in the literature by domestic and foreign scholars. Balogun et al. [16] found that digital technology has a positive impact on carbon emission reduction and sustainable development after conducting case studies on cities on various continents. Chen [17] empirically tested the impact of digitization on carbon emissions by taking BRICS (Brazil, Russia, India, China, and South Africa) countries as samples and found that digital technology would significantly reduce carbon emissions. Li et al. [18] empirically tested the impact of energy structure and digital economy on carbon emissions based on the extended STIRPAT model. Their results showed that an energy structure dominated by coal has a significant driving effect on carbon emissions and the digital economy has a significant regulating effect. Saqib [19] studied 13 emerging Asian economies and 63 emerging and developed economies and found that economic growth and non-renewable energy consumption exacerbated environmental degradation, while renewable energy consumption reduced the adverse impact on the environment over time. At the same time, in the long run, economic growth will play a positive and significant role in the use of renewable energy [20] Katircioglu et al. [21] examined the impact of tourism growth on the emission of pollutants in the northern part of Cyprus and showed that tourism has a significant long-term impact on carbon emission levels and that tourism growth would lead to environmental deterioration. Rej et al. [22] argued that paradigms of sustainable tourism policy impact are designed to prioritize the decoupling link between tourism development and environmental degradation and confirmed that higher international tourist numbers, use of renewable energy, and total capital formation can curb emissions in the long run. Surprisingly, for developing economies such as Sub–Saharan Africa (SSA), machinery imports can also significantly reduce carbon emissions, but not as much as renewable energy [23].

In China, Deng and Zhang [24] found that a digital economy reduces the emission of various pollutants, and that the emission reduction effect on sulfur dioxide is the most obvious. Xie [25] concluded that a digital economy could reduce carbon emission intensity through an improvement in the energy structure and the advancement of partial technology, especially in central and western China. Cha et al. [26] pointed out that there is a significant positive correlation between tourism growth and carbon emissions through an empirical analysis. Bian et al. [27] found through data research that the waste treatment sector has significant potential to reduce greenhouse gas (GHG) emissions. Emission strategies to reduce GHG should be formulated based on waste generation and disposal conditions, level of economic development, and each region and province's operation and management level. Shang et al. [28] conducted a survey, and based on a quantitative analysis of the results, suggested that ASEAN governments should promote renewable energy certificates (REC), because clean energy is an appropriate way to control environmental quality by reducing carbon emissions. Chien et al. [29] investigated the impact of information and communications technology (ICT) development, economic growth, and financial development on CO_2 emissions, and confirmed that the explanatory influence variable varies with different quantiles of CO_2 emissions. It is evident from the above that the research directions and the results of studies are not uniform, and that the different conclusions may be caused by differences in sample time and national institutional background. Digital technology is changing rapidly and the carbon emission reduction

effect in different time periods and regions are likely to differ. It is certain, though, that the carbon emission reduction effect of the digital economy has greatly hindered the process of global warming, and this was one of the key topics of the Glasgow Climate Conference COP26, which has a great impact on the sustainable development of the economy and the ecological environment. The goals of green ecology may be close at hand.

On whether the digital economy will promote trade in services, Gonzalez and Ferencz [30] concluded that in the era of digital economies, transnational corporations are fully entering the stage of digital transformation. Besides the income from product sales and product services, transnational corporations are gaining a third kind of income from data service trade. Li [31] adopted interdisciplinary research methods—comparative research, statistical research, and quantitative analysis—and found that the digital economy has driven the transformation and upgrading of China's service trade industry.

What about international trade in tourism services? Kesgin et al. [32] found that the enthusiasm of residents in tourist destinations promoted the development of the local tourism service trade. Razzaq et al. [33] examined the relationship between tourism development, technological innovation, and carbon emissions by testing the assumptions of China's environmental Kuznets curve (EKC). Based on the asymmetric emission reduction effects of tourism and technological innovation, they concluded the Chinese government should implement a policy of tourism–technology integration. Zhou and Zhou [34] analyzed the international market share, service competitiveness index, and comparative advantage index of tourism service trade before the outbreak of COVID-19 and applied revised diamond and gravity models. They found that training tourism talents, improving infrastructure, and expanding investment can enhance the international competitiveness of China's tourism service trade to a certain extent. Zhang and Lao [35] used the competency-based education (CBE) model to create a modular design for a curriculum system for tourism service trade to match talent training objectives, teaching content, and practical abilities, and cultivate more comprehensive, innovative, and applied talents for the tourism service trade to improve the level of service in the tourism trade. Geng and Zhang [36] studied the factors that influence the competitiveness of China's tourism industry from two aspects: resource endowment and institutional constraints. They found that the factors that significantly promote tourism include the number of star hotels, tourism labor productivity, high-quality talents, trade openness, and foreign direct investment.

To summarize, although the literature review produced relatively rich research results, there are still areas to be expanded: First, previous studies focused on the impact of traditional factors on international tourism, such as transport infrastructure, residents' consumption levels, trade systems, and cultural distance, which are mostly based on bilateral or multilateral research models. However, the world is now in a post-epidemic era. More attention should be placed on whether the internal changes of a country will have an impact on the international tourism industry. Second, as the second largest economy in the world, there are few empirical studies on the development of China's digital economy and its international tourism trade. These studies are generally limited to a single level, such as the Internet, and cannot accurately describe the specific role of the digital economy in promoting tourism. Third, in the context of global warming and the official signing of the Glasgow Climate Convention, low-carbon tourism is gradually coming into the public's view; however, what role carbon emission will play in the influence path of digital economy on tourism service trade is seldom covered by present studies.

2.2. Theoretical Mechanism Analysis

From a supply side perspective, a digital economy not only promotes the upgrading of the tourism infrastructure but also deepens the integration and penetration of ICT and the services industry. New trade formats and modes are constantly emerging that reduce information asymmetry and costs in the traditional tourism services industry [37]. The digital economy has strong elements of permeability and integration [38]. Digital technology's integration with the tourism service industry facilitates the flow of data, which

in turn leads to the convergence of technology flow, capital flow, and talent flow in the tourism industry, and promotes optimal resource allocation and improves total factor productivity. In addition, ICT has changed the way information is transmitted and improved the efficiency and quality of information transmission at tourist attractions. It thus plays a significant role in reducing market segmentation and promoting the development of trade in local tourism services. The wide application of digital technology not only drives structural transformation and upgrading of the tourism service trade, but also promotes breakthrough changes in the service industry and service trade, resulting in many new formats and new modes. This in turn produces fundamental changes in the processes, technology, experiences, and other aspects of the tourism service trade.

For example, data mobility has generated new types of tourism service trade, such as the live streaming of tourist attractions and cross-border e-commerce sales of tourism cultural products through the implementation of digital tourism products and transactions on digital platforms. This has allowed tourism services to break through the constraints of the COVID-19 outbreak, and the scope and convenience of trade have been greatly increased. At the same time, with the extensive use of information technology, travel operators can fully understand the domestic and foreign market information through Internet search engines and digital advertising, thus greatly reducing the costs associated with data collection. In terms of information output, the Internet, microprocessors, ICT, and other digital technologies provide a more efficient and cheaper way to market tourist attractions. Compared to establishing marketing channels and offline advertising, online advertising, and websites are not only cheaper for operating enterprises, but are also able to target advertising based on the types of tourists [39]. Operators of tourist attractions can collect information on customers and use historical data to analyze customer behavior and trends, develop scientific and affordable travel itineraries, create more targeted tourism products and services, travel service monitoring and tracking to ensure the smooth development of tourism services, and obtain market prices in a short time. Digital platforms, such as Meituan and Dianping, promote the characteristics of tourist attractions, introduce tourism and cultural products, and obtain timely customer feedback. Digital software, such as Amap and Didi Taxi, helps tourists to save time and costs. Through statistical analyses, human–computer interaction, and other digital technologies, tourist data can be presented as graphic and visual images for convenient transmission and communication to improve the efficiency of one-stop tourism services. These new formats and models not only enrich the content of the tourism service trade, but also broaden the field and boundaries of the tourism service trade, and improve the range of tourism services in the international trade market.

From a demand-side perspective, a digital economy can on the one hand increase consumers' demand for traditional tourism services, and on the other hand also create a new demand for digital tourism services. With the development of the digital economy and the application of digital technology in the tourism service industry, the ability of tourists to obtain information has improved significantly, and the supply of available tourism service products is also more diversified, thus increasing the demand for higher standards and quality of tourism service products. At the same time, the integration of the digital economy and the tourism industry, has expanded the way tourists share information through various tourism platforms and bulletin board systems (BBS) that publish tourist experiences. Traditional travel services can also use digital technology to improve their influence, expand their services to potential tourist groups, increase their range of services, and to gain a competitive advantage in the market.

The development of a digital economy also drives the transnational flow of data. Tourists' demands for services are no longer just satisfied with a longitudinal historical comparison, but are more inclined toward a horizontal comparison in the international tourism market to meet their expectations for better services. These changes also increase the scale of the traditional tourism service trade. The gradual penetration of the digital economy into the tourism industry has even subverted the interaction between individuals

and society. The increasing popularity of digital technology has brought about a deepening of the digitization of tourists' consumption behavior, so that tourists have gradually formed digital consumption habits and behaviors. Therefore, when choosing tourism services, scenic spots with more convenient digital services are usually preferred. Stimulated by a large amount of data and information, some tourists are prone to impulsive tourism and tend to favor "scenario-triggered tourism", thus transforming immediate tourism needs into actual tourism behaviors and stimulating the booming demand for experiential, interactive, and one-stop digital tourism services. In addition, the development of a digital economy shifts tourists' concept to individuation and diversification, and tourism types and modes to differentiation and diversification, thus greatly increasing the demand for digital tourism services [40].

To summarize, a digital economy—from both the supply side and demand side—can promote the development of tourism services, reduce the costs of the service trade, improve the efficiency of the service trade, and give remote scenic spots access to the national and even the global tourism market. Next, we consider whether the digital economy always has a direct effect on the tourism service trade. There can be many reasons why this might not happen, especially in the context of curbing global warming and controlling carbon emissions in various countries after the Glasgow Climate Conference in the UK in 2021, where the call for "low-carbon tourism" has increased. After a review of the literature, this paper tries to introduce per capita carbon emissions as a mediator variable. As mentioned earlier, the development of a digital economy can significantly reduce the intensity of regional carbon emissions. At the same time, we conclude that carbon emissions affect the tourism service trade mainly through scale, technology, and structure effects. First, carbon emissions have an inverted U-shaped impact on the tourism industry. Under low-carbon policies, an increase in carbon emissions in the initial stage will inhibit the development of tourism; however, with the continuous optimization of all links, low-carbon tourism will continue to be accepted by the public; thus, this scale effect first suppresses and then increases tourism. Second, carbon emission will promote the continuous upgrading of the tourism service industry, which will radiate outward through low-carbon technology, resulting in a technological effect and thus, promote the service trade. Last, when "low-carbon tourism" is dominant, in the early-stage capital, manpower and technology have a positive net effect, which gradually improves energy efficiency. In turn, this enhances the ecological sustainability of tourism, optimizes industrial structure upgrades and technology research, and increases development efficiency, thus forming the structure effect, which further enhances the standards of tourism trade in services. Based on the above mechanism analysis, we posit that carbon emissions may play an intermediary role in the influence of digital economy on international tourism service trade. The specific empirical analysis will be shown in the next section.

3. Model Construction and Data

3.1. Model Construction

This paper uses panel data of 30 Chinese provinces (except Hong Kong, Macao, Taiwan, and Tibet) from 2011 to 2019 to construct a bidirectional fixed effect model to investigate the impact of the development of digital economy on tourism service trade; the two-way fixation means that time and province are controlled at the same time to reduce the influence of the relevant omitted variables or other factors to make the results of this paper more reliable and robust. As the role of time on the development of digital economy cannot be ignored and the influence of the digital economy on the tourism service trade may be non-linear, we refer to Xiang et al. [41] and introduce a quadratic term for the variable for the development of the digital economy to establish the following benchmark regression model:

$$\ln itr_{it} = \alpha + \alpha_1 de_{it} + \alpha_2 de_{it}^2 + \alpha_3 control_{it} + \mu_i + \phi_t + \varepsilon_{it} \quad (1)$$

where i is the province, t is the year, lnitr is the logarithmic value of foreign exchange income from international tourism, de is the development of the digital economy at a provincial level, $control_{it}$ is the control variable in the equation, which includes foreign direct investment (*fdi*), goods export trade (*ex*), ticket revenue of scenic spots (*ticket*), level of traffic facilities (*transport*), and accommodation level (*hotel*). To alleviate the endogenous problem of the missing variables, we controlled the fixed effect of province and year with μ_i and φ_t, where ε_{it} as the random error term. To eliminate the influence of heteroscedasticity between provinces, a robust clustering standard error was included in the subsequent analysis.

To test the possible mechanism of action between digital economy and tourism service trade, we refer to Wen and Ye's mediating effect test method [42]. On the basis of Equation (1), we take carbon emissions as an intermediary variable and add it to the same analytical framework with digital economy and tourism service trade and set up the regression equation as follows:

$$lnperce_{it} = \beta + \beta_1 de_{it} + \beta_2 de_{it}^{\ 2} + \beta_3 control_{it} + \mu_i + \varphi_t + \varepsilon_{it} \quad (2)$$

$$lnitr_{it} = \gamma + \gamma_1 de_{it} + \gamma_2 de_{it}^{\ 2} + \gamma_3 lnperce_{it} + \gamma_4 control_{it} + \mu_i + \varphi_t + \varepsilon_{it} \quad (3)$$

According to the test method of Wen [40], α_1 in Equation (1) represents the total effect of the digital economy on the tourism service trade; β_1 and γ_3 in Equations (2) and (3) represent the intermediary effect of carbon emissions; and γ_1 represents the direct impact of the digital economy on the tourism service trade in the dimension of per capita carbon emissions. On the basis of α_1 significant: if β_1 and γ_3 are significant, and when γ_1 is significant, there is a partial mediation effect of carbon emission, but if γ_1 is not significant, it is a complete mediation effect; if either β_1 or γ_3 is not significant, a bootstrap test is performed, and a positive test indicates the existence of a partial mediation effect.

3.2. Data Measurement and Description

3.2.1. Explained Variable

The tourism service trade level (*itr*) is the explained variable. Many indicators can be used to measure a country's tourism trade in services. Based on the availability of data availability and under the premise of cited frequency, this study used foreign exchange income from international because it can directly reflect the degree of international tourism service trade export [43].

3.2.2. Core Explanatory Variable

Level of development of digital economy (de) is the core explanatory variable. There is no unified approach to measure the development level of digital economy at a province level. Considering the availability of data and referring to Zhao et al. [44], this paper measures the level of digital economy in each province from the perspectives of Internet development and digital inclusive finance. To measure Internet development, Huang et al. [45] adopted four indicators, namely, the Internet penetration rate (the number of broadband users per 100 people), Internet-related employees (the proportion of computer service and software employees in urban units), relevant output (the total amount of telecom services per capita), and mobile phone penetration rate (the number of mobile phone users per 100 people). To measure the development of digital inclusive finance, we adopted the China Digital Inclusive Finance Index, which is jointly compiled by the Peking University Digital Finance Research Center and the Ant Financial Group [46]. Missing values were supplemented using a linear interpolation method. The data of the five indicators were standardized and dimension reduction processing by principal component analysis to obtain the development level of digital economy. The principal component weights for Internet penetration rate, Internet-related employees, relevant output, mobile phone penetration rate, and digital finance were 0.713, 0.139, 0.090, 0.046, and 0.012, respectively (Table 1).

Table 1. Digital economy development level index system. "+" means the indicator is positive and has a promoting effect.

First Level Indicators	Second Level Indicators	Third Level Indicators	Index Attribute
Level of development of digital economy	Internet penetration rate	Internet users per 100 people	+
	Number of Internet-related employees	Percentage of computer services and software employees	+
	Internet-related output	Total telecom service per capita	+
	Mobile Internet Users	Number of mobile phone users per 100 people	+
	Inclusive development of digital finance	China Digital Financial Inclusion Index	+

3.2.3. Intermediate Variable

Per capita carbon emissions (perce) is the intermediate variable. According to the above analysis, a digital economy can promote the development of China's tourism service trade level by reducing carbon emissions. Considering the availability of data, this paper adopts per capita carbon dioxide emissions of each province as a measure. According to the fourth assessment report of the Intergovernmental Panel on Climate Change [47] in 2007, the main source of the increase in GHG is fossil fuel combustion. Therefore, this paper calculates carbon emissions per capita based on the consumption of nine energy sources (coal, coke, crude oil, gasoline, kerosene, diesel, fuel oil, natural gas, and liquefied petroleum gas) in the Chinese Stock Market & Accounting Research (CSMAR) database. The calculation method is based on the IPCC Guidelines for National Greenhouse Gas Emission Inventory 2006, and the specific formula is as follows:

$$perce_{it} = (\sum E_{ijt} * \eta_j)/people_{it} \ (i = 30; j = 1, 2, \cdots 9) \quad (4)$$

where $perce_{it}$ is the total carbon emissions of province i in year t; E_{ijt} is the j-th energy consumption in year t of province i; η_j is the carbon emission coefficient of the j-th energy; and $people_{it}$ is the total population of province i at the end of year t. Since the consumption of energy in the original statistics was presented as physical statistics, it was converted into standard statistics to calculate carbon emissions. In this paper, the carbon emission coefficients of the different types of energy are determined according to the China Energy Statistical Yearbook. Total carbon dioxide emissions were calculated as the sum of the physical statistics of the nine energy categories, *, the carbon emission coefficient, which was then divided by the population size of each province at the end of the year to calculate carbon emissions per capita.

3.2.4. Control Variables

The five control variables are foreign direct investment (fdi), goods export trade (ex), ticket revenue at scenic spots (ticket), traffic facility level (transport), and accommodation level (hotel).

Foreign direct investment (*fdi*) is measured as the total investment of foreign-based enterprises registered at the end of the year. Relevant studies have shown that investing enterprises or individuals tend to import capital goods or related services from their home countries, and *fdi* is also the best way to exchange services. The scale of foreign direct investment will therefore have an important impact on the services trade [48].

The goods export trade (*ex*) is measured as the total exports of goods. Many studies in the literature found a high correlation between trade in services and trade in goods, and that an increase in the trade of goods can drive the effective demand for trade in services [49,50]. The impact of the scale of the trade in goods on the trade in services should therefore be considered in the empirical study.

Ticket revenue of scenic spots (*ticket*) is measured by the total ticket revenue of scenic spots in each province. The "ticket economy" has influenced tourists' willingness to travel. In 2020, the Hainan government launched a tourism revitalization plan to counteract the effect of COVID-19 by offering medical staff free admission to local scenic spots and reduced ticket prices for some holidays [51]. This plan enabled Hainan to receive about 64.55 million tourists in that year, and the total tourism revenue was about 87.3 billion yuan, almost 80% of the pre-epidemic level. Promoting the transformation and upgrading of service trade in Hainan tourist attractions also produced remarkable results.

Traffic facility level (*transport*) is measured by the fixed asset investment of the whole society in transportation, storage, and postal services. In the choice of tourist destinations, the convenience of transportation is an important factor in tourists' decision-making [52]. The accessibility of regional tourism is very important in tourists' evaluation and selection until the final destination is determined. At the same time, the convenience of transportation also affects the travel path of tourists.

Accommodation level (*hotel*) in each province is measured as the total assets of registered accommodation enterprises. Yiu and Cheung [53] have pointed out that governments around the world are on the road to recovery from the COVID-19 crisis, but improved accommodation levels are critical for sustainable tourism planning, especially in the tourism services sector, which enhances the resilience of destinations.

3.3. Data Sources

This paper uses data on 30 provinces (municipalities and autonomous regions) as samples (excluding Tibet, Hong Kong, Macao, and Taiwan) from the China Statistical Yearbook, the China Energy Statistical Yearbook, the website of the National Bureau of Statistics, the statistical yearbook of each province, the CSMAR database, and digital economy development reports. Missing values in the panel data were supplemented by linear interpolation. To counter the influence of extreme values, all continuous variables were tail-tailed at 1% and 99%. To alleviate heteroscedasticity interference by data fluctuation, some data were logarithmic. To avoid pseudo regression phenomenon due to correlations between variables, a variance inflation factor (VIF) test was carried out, and the test result showed that the mean value was 3.23, so no serious multicollinearity was found in the selected index data. The descriptive statistics of variables are shown in Table 2.

Table 2. Descriptive statistics of variables.

Variable Name	Obs	Mean	Std. Dev.	Min	Max
lnitr	270	6.918	1.587	2.319	9.902
de	270	0.740	1.110	−0.919	4.818
de^2	270	1.775	3.804	0.000	23.218
lnperce	270	2.216	0.562	1.348	3.727
lnfdi	270	6.570	1.366	3.432	9.777
lnex	270	14.717	1.558	10.758	17.979
lnticket	270	3.090	0.865	0.779	4.919
lntransport	270	7.026	0.808	4.730	8.559
lnhotel	270	5.555	0.919	3.131	7.452

4. Empirical Test

4.1. Benchmark Regression

Table 3 shows the benchmark regression results of the impact of the digital economy on China's tourism service trade. This paper adopts a progressive regression processing method. First, a univariate regression is carried out by controlling the fixed effects of provinces and years (Table 1). Second, the relevant control variables are included for testing on the basis of controlled provinces and years (Table 2). Last, a clustering robust standard error is adopted to eliminate the influence of heteroscedasticity among provinces on the basis of previous studies (Table 3). The results show that the digital economy has

a significantly positive impact on tourism service trade, and the empirical test is highly robust. From the empirical results of Models 2 and 3, it can be seen that the coefficient before each variable is the same, but the value in ( ) has changed slightly because we cluster at the province level and eliminate the heteroscedasticity results among provinces. The two comparisons show that even if the heteroscedasticity is eliminated, the coefficient of each variable does not change. This confirms the credibility of the empirical results of this study, and also represents the rationality of the model setting, indicating that the development of the digital economy does significantly promote the improvement of China's tourism service trade level.

Table 3. Benchmark regression results of digital economy and tourism service trade.

	(1) **lnitr**	**(2)** **lnitr**	**(3)** **lnitr**
de	0.541 ***	0.477 ***	0.477 ***
	(0.154)	(0.136)	(0.165)
de^2	−0.069 ***	−0.064 ***	−0.064 ***
	(0.015)	(0.013)	(0.020)
lnfdi		0.450 ***	0.450 ***
		(0.082)	(0.120)
lnex		0.235 ***	0.235 **
		(0.065)	(0.092)
lnticket		−0.137 ***	−0.137 **
		(0.039)	(0.056)
lntransport		0.172 ***	0.172 **
		(0.044)	(0.072)
lnhotel		0.180	0.180
		(0.118)	(0.142)
_cons	6.885 ***	−0.918	−0.918
	(0.073)	(1.116)	(1.362)
Provincial fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Observations	270	270	270
R-squared	0.328	0.519	0.519

Note: ***, **, and * represents significant at the level of 1%, 5%, and 10%, respectively; the clustering robust standard error is in parentheses of result (3).

In general, each unit increase in the development level of digital economy will increase the level of China's tourism service trade by 0.477 units. This means that the digital industry, industrialization of the digital direct effects on tourism services, standardization, generalization, and modularization at the very low cost of digital technology in the travel service industry facilitate internal cultivation and diffusion between and across industry, and produce more efficient service levels and a larger service trade. In other words, the effect of digital economy is increasingly evident. In terms of the control variables, foreign direct investment, goods export trade, and transportation facility level have a positive effect on the real economy, which is significant at the level of 1% and 5%. This shows that reasonable foreign investment provides the necessary conditions for the development of tourism service industry and solves the financial problem to a certain extent, while the degree of transportation convenience will affect the travel plan and travel time of tourists. The scale of trade in goods can drive the effective demand for trade in services, and these two factors cannot be ignored. In addition, ticket prices of provincial scenic spots are significant at the level of 5%, which has a negative impact on tourism service trade and hinders tourists' travel intentions.

4.2. Mediating Effect Test

The possible mechanism of the digital economy and tourism service trade has already been described in detail based on the results of earlier studies. Therefore, carbon emissions per capita was selected as the intermediary variable, and a mediation effect model was

established to test whether it played a certain role, referring to the step-by-step test method of Wen et al. [42].

The first step is to test the total effect of the digital economy on tourism service trade by using Equation (1). The results are shown in column (1) of Table 4, and show that the higher the level of digital economy, the greater the volume of tourism service trade in each province. There is a significant positive correlation between the two, and coefficient α_1 is the total effect of the independent variable on the dependent variable.

Table 4. Mediating effect model regression.

Variable	(1) lnitr	(2) lnperce	(3) lnitr
de	0.477 ***	0.097 *	0.525 ***
	(0.165)	(0.052)	(0.172)
lnperce			−0.497 *
			(0.285)
Control variable	Yes	Yes	Yes
Provincial fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Observations	270	270	270
R-squared	0.519	0.161	0.531

Note: ***, **, and * represents significant at the level of 1%, 5%, and 10%, respectively; the clustering robust standard error is presented in parentheses.

The second step is to test whether the digital economy has a significant impact on per capita carbon emissions by using Equation (2). The results are shown in column (2) of Table 4. At a 10% level, the digital economy has a weak promoting effect on carbon emissions per capita in the early stage, which confirms Miao et al. [54]'s result, namely, that digital economy has an inverted U-shaped relationship with carbon emissions. In the early stage of the development of digital economy—due to the immature development of the digital economy in the process of digital industrialization and industrial digitization—the high input and high cost caused by the digital economy increases carbon emission levels in production and life. As the digital economy continues to mature capital, manpower and technology input in the early stage will gradually have a positive net effect, energy utilization efficiency will improve, industrial structure will be optimized and upgraded, and technology research and development efficiency will improve, thus gradually reducing the level of carbon emission.

Since the first two steps have verified that the coefficients α_1 and β_1 are significant, in the third step, the independent variable and the intermediary variable are put into the model in Equation (3) to test whether their influence on the dependent variable is significant and analyze whether the intermediary variable is fully or partially mediated. The results are shown in column (3) of Table 4 and show that the digital economy and carbon emissions per capita are correlated with tourism service trade at the level of 1% and 10% respectively. This indicates that carbon emissions per capita have a partial intermediary effect, namely, an indirect effect, between the digital economy and tourism service trade, and its value is the product of coefficients β_1 and γ_3 (-0.048). The coefficient $\gamma_1 = 0.525$ is the direct effect of the digital economy on the tourism service trade. The coefficient sign of the direct effect is opposite to the coefficient sign of the indirect effect, indicating that the total effect appears to be covered as introduced by Wen et al. [42], that is, the covering effect and its absolute value is lower than expected. The results show that the total effect of 0.477 is indeed lower than the direct effect of 0.525.

4.3. Robustness Test

4.3.1. Replace the Explained Variable

In the previous section, the tourism service trade volume of each province is used to measure the level of tourism service trade. After fully referring to the studies of other

scholars and considering the availability of data, the number of inbound overnight tourists (*lnnumber*) in each province is used for the robustness test. The results are shown in Model (1) and Model (2) in Table 5. Regardless of whether the control variables are added, the influence coefficient of the digital economy is significant at the 1% level, which is consistent with the benchmark regression results.

Table 5. Robustness test regression.

	(1) lnnumber	(2) lnnumber	(3) lnitr	(4) lnitr	(5) lnitr
de	0.502 ***	0.501 ***			0.450 **
	(0.164)	(0.171)			(0.195)
de^2	−0.044 ***	−0.038 ***			−0.081 *
	(0.012)	(0.012)			(0.041)
dige			0.894 ***	0.643 ***	
			(0.290)	(0.198)	
$dige^2$			−0.060 ***	−0.040 ***	
			(0.018)	(0.010)	
_cons	5.263 ***	0.921	5.626 ***	−0.712	1.416
	(0.087)	(2.194)	(0.345)	(1.461)	(2.221)
Control variable	No	Yes	No	Yes	Yes
Provincial fixed effect	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes
Observations	270	270	270	270	180
R-squared	0.288	0.365	0.344	0.496	0.459

Note: ***, **, and * represents significant at the level of 1%, 5%, and 10%, respectively; the clustering robust standard error is presented in parentheses.

4.3.2. Replace the Explanatory Variable

We refer to Zhao et al. [44] to use principal component analysis to weight and evaluate the digital economy indicators. Now, we take Miao et al. [54] as a reference and use the entropy weight method to calculate digital economy level (*dige*) and then perform a regression as shown in Table 5, Models (3) and (4). Regardless of whether control variables are added, the results are also significant at the 1% level, which fully verifies the robustness of the empirical study.

4.3.3. Shorten the Regression Sample Time Dimension

To investigate whether the impact of the digital economy on the tourism service trade is affected by the timeframe of the study, this paper refers to the method used by Luo and Liu [55] and shortens the sample interval to 2014–2019 before carrying out the regression analysis. In this step, the total number of samples was reduced from 270 to 180. The results are shown in Model (5) in Table 5. It is still significant at the 5% level, which again demonstrates the credibility and rigor of this study.

4.4. Endogenous Processing

Although the bidirectional fixed effect model adopted in this paper can effectively solve the endogenous problem caused by the omission of individual or time variation factors, it cannot effectively solve the endogenous problem caused by causality. This paper therefore adopts an instrumental variable method to conduct the endogenous test, which takes the lag term of digital economy development level as the instrumental variable, and adopts a two-stage least square method (2SLS) to conduct the endogenous test. Models (1) and (2) in Table 6 report the results of the regression of the instrumental variables in detail. Regardless of whether the control variables are added, the impact of the digital economy on the tourism service trade is significant at the level of 1%, indicating that the basic conclusion is still robust after considering the endogenous problem. In addition, the *p*-values of the Lagrange multiplier (LM) statistics of Kleibergen–Paap rk are all 0.000, which overturns the null hypothesis, thus indicating that there is no problem of an insufficient identification

of instrumental variables. The Wald F statistics of the Kleibergen–Paap rk are all larger than the critical value (7.03) of Stock–Yogo's weak identification test at the level of 10%, indicating that it is reasonable to select the lag term of the development level of digital economy as an instrumental variable.

Table 6. Two-stage least square (2SLS) regression.

	(1) **lnitr**	**(2)** **lnitr**
de	0.671 ***	0.600 ***
	(0.225)	(0.173)
de^2	−0.060 ***	−0.065 ***
	(0.016)	(0.014)
Control variable	No	Yes
Provincial fixed effect	Yes	Yes
Year fixed effect	Yes	Yes
Kleibergen–Paap rk	15.297	14.528
LM statistic	(0.000)	(0.000)
Kleibergen–Paap rk	28.466	26.748
Wald F statistic	{7.03}	{7.03}
Observations	240	240
R-squared	0.294	0.509

Note: The ( ) value is the *p*-value, and the { } value is the critical value at the 10% level of the Stock–Yogo weak recognition test, *** represents significant at the level of 1%.

4.5. Heterogeneity Analysis

4.5.1. Regional Heterogeneity

Different areas exhibit differences in foreign direct investment, residents' consumption levels, and traffic infrastructure. As a result, different regions have different capacities in construction and adaptation. This paper therefore takes geographical regions as the boundary for discussion. Columns (1) and (2) in Table 7 show the regression results of the digital economy on tourism service trade in inland regions and coastal regions, respectively. The results show that the digital economy only promotes tourism service trade in inland areas, and it is significant at the level of 1%. This is mainly because the coastal provinces have a higher level of economic development and a deeper degree of digitalization. In the inland areas, the development of the digital economy is slower and the penetration degree of tourism is shallow, thus hindering the development of the tourism service trade. However, with the large-scale development of a digital economy in recent years, the development status of inland tourism has also changed. With its advanced technological advantages, digital economy has penetrated all aspects of the tourism service industry and greatly improved the scale of inland tourism service trade, with obvious advantages to "backwardness".

4.5.2. The Heterogeneity of Tourism Resource Endowment

The development of tourism in China's provinces will differ according to their natural resources and geographical conditions. Therefore, this paper takes the number of 5A scenic spots in each province (until 9 June 2021) as the basis for the classification, selects 10 scenic spots as the limit, and divides them into two regions with higher and lower tourism resource endowments for the sub-sample regression. The results summarized in columns (3) and (4) of Table 7 show that the digital economy only plays a significant role in promoting provinces with higher resource endowments, and it is significant at the level of 5%. As Marco-Lajara [56] concluded, this is mainly due to the industrial aggregation effect and social network effect in areas with developed tourism resources, which shows that tourism has a complex internal development mechanism. Under the enabling effect of the digital economy, there is a complex social network and industrial chain mechanism among tourism related stakeholders. On the one hand, the sharing of knowledge, market information,

and other digital aspects promotes the innovation of tourism services; on the other hand, the digital division of labor between different tourism links provides diversified products and services for tourism consumers, which sustains the tourism industry's continuous development. At the same time, the quality of tourism practitioners continues to improve, and regions' impact resistance and external technology capacity are also improving. The interaction between digital economy and the agglomeration effect is the internal reason for the significant improvement of service trade in the regions with tourism resource endowments, while the regions with fewer endowments cannot give full play to their scale advantages due to backward industry and poor talent cultivation. They also find it more difficult to integrate digital technology more efficiently.

Table 7. Heterogeneity analysis.

	(1) Inland	(2) Coastal	(3) Higher Endowment	(4) Lower Endowment
de	0.437 ***	0.252	1.172 **	0.359
	(0.113)	(0.504)	(0.414)	(0.261)
de^2	−0.078 ***	0.013	−0.150 **	−0.048
	(0.011)	(0.076)	(0.063)	(0.021)
_cons	2.303	−6.480	2.809	−2.453
	(1.347)	(7.589)	(3.778)	(1.776)
Control variable	Yes	Yes	Yes	Yes
Provincial fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Observations	117	63	108	135
R-squared	0.771	0.488	0.571	0.566

Note: ***, **, and * represents significant at the level of 1%, 5%, and 10%, respectively; the clustering robust standard error is presented in parentheses.

5. Conclusions and Policy Recommendations

5.1. Conclusions

The development of all industries in China has to some extent stalled over the past two years under the impact of COVID-19. The impact on the tourism service industry has been particularly serious. Shang et al. [57] found that increasing the involvement of government authorities can mitigate the impact of disease outbreaks. Especially in the context of the global post-epidemic era, it is necessary to consider how the achievements of the third technological revolution can be used to alleviate the current downward pressure on the economy, especially in terms of government policy-making. The development of the digital economy can continue to promote the goal of "carbon peak, carbon neutral" and guide the structural transformation of the tourism service industry and drive economic development.

Although the above literature review has produced relatively rich research results and shows that the digital economy will directly affect service trade through digital technology, there are still some areas to be expanded: previous studies mainly focused on the impact of traditional factors on international tourism, such as transportation infrastructure, residents' consumption level, etc., and were mostly based on bilateral or multilateral research models. Less attention has been paid to the impact of internal changes in a country. Moreover, China, as the second largest economy in the world, has few empirical studies in this regard and is limited to a single level, which cannot accurately describe the role of the digital economy in promoting tourism and the specific path of carbon emissions in this process. Therefore, in this paper, we take advantage of the carbon emission reduction effect of the digital economy, innovatively put the digital economy, tourism, and carbon emissions in the same framework, build a unified mathematical model for comparative analysis, verify the relationship between the three and provide an economic explanation. Possible contributions are a more comprehensive perspective on the construction of a model of the

impact of China's digital economy on international tourism service trade and an analysis of the impact mechanism of the digital economy on international tourism; and a study of the heterogeneous impact of China's digital economy on international tourism based on geographical location and tourism resource endowment. Further, the mediating role played by carbon emissions is discussed and validated with empirical analysis to deepen the existing literature. The research results can be summarized as follows:

(1) Digital economy plays a significant role in promoting the development of China's tourism service trade. On average, the level of the tourism service trade will increase by 0.477 units when the development level of the digital economy increases by 1 unit. The digital economy is one of the key factors to promote the recovery of the tourism service trade.
(2) From the perspective of an action mechanism, the digital economy not only directly drives the growth of the tourism service trade through the change of new internal driving forces, such as digital industrialization and industrial digitalization, but also creates new demands and new business forms on both the demand side and the supply side, and optimizes all links and improves service efficiency. In addition, nature and the introduction of digital technology and digital elements to a certain extent inhibit the carbon emissions, improve the level of regional ecological health and air environmental quality, and also indirectly promote the development of tourism service trade through three effects. Therefore, the mediating role of carbon emissions is also one of the factors to consider in the future.
(3) The enabling effect of the digital economy on the tourism service trade shows obvious heterogeneity. This finding is certainly valid for local policy-making. In geographical locations, due to the "late-mover advantage" in inland regions, the digital economy has a stronger promoting effect on tourism service trade. In terms of tourism resource endowment, the promotion effect of the digital economy on tourism service trade in regions with higher resource endowments is more prominent, which may be the result of an interaction between the industrial cluster effect and the digital economy.

5.2. Policy Recommendations

This paper provides empirical evidence for guiding the recovery of tourism service trade in the post-epidemic era, promoting the construction of "digital China" and the "dual carbon" goal, provides ideas for relevant countries at the COP26 meeting to control carbon emissions and curb the process of global warming, and makes the following policy recommendations:

First, China needs to formulate macro policies, control the domestic and international trends in the epidemic development, and steadily and comprehensively promote the recovery of domestic industries in the post-epidemic era. Full consideration should be given to research results of scholars from all walks of life, including the government's participation in mitigating the impact of the disease [55]. The government should formulate post-epidemic tourism service development policies to reduce the long- and short-term impact of COVID-19 on tourism.

Second, the construction of digital infrastructure and the enabling effect of the digital economy on trade in services should be enhanced. The tourism service industry is one of the important sectors of the national economy. The empirical results of this paper have shown the important role of the digital economy, and that it is one of the key factors to guide the industry's recovery. Digital infrastructure is the cornerstone of the development of a digital economy. To promote the development of the digital economy, superior digital infrastructure is needed, especially in rural or remote areas. The coverage and sharing rate of digital infrastructure should be improved, the digital divide should be eliminated, full play should be given to the advantages of being latecomers, and favorable conditions should be provided for the digital economy to empower the tourism service trade. At the same time, China should strengthen the research and development and investment in digital technology, promote the penetration of digital technology into the tourism service

industry, and smooth the transmission of the information chain and value chain in all aspects of tourism.

Third, differentiated promotion measures should be taken based on different geographical locations and tourism resources. This study has confirmed the existence of heterogeneity. For inland regions with a relatively slow development of the digital economy and provinces with large endowments of tourism resources, the government should adjust the development of the digital economy, increase support, give full play to the enabling effect of the digital economy, make up for the shortcomings of the development of tourism service industry, and improve the development efficiency of tourism service industry.

Fourth, taking the carbon emission reduction effect of the digital economy and the intermediary role of carbon emissions into full consideration—although a masking effect appears in the empirical analysis of this paper—China could start from three aspects, namely, the scale effect, technology effect, and structure effect. The development of low-carbon technologies and green innovative technologies should be pursued to promote the development of tourism and its service trade and create "low-carbon tourism", gradually advancing the goals of the COP26 meeting.

Fifth, openness and cooperation in the digital economy should be strengthened to promote win–in outcomes for both sides and other parties in tourism service trade. A country's digital economy development can not only promote the development of its tourism services trade; it can also—through the carrier function—accelerate the reinforcement effect, the effect of channels, the trade effect on other countries or regions, such as the pace of the positive spillover effect or cultural transmission, and thus promote the development of the global travel service trade, especially in the post-pandemic era. Countries and regions across the globe share common interests in the digital economy.

Last, international tourism cooperation can be strengthened and a platform for trade in services can be developed. In the post-epidemic era, China should adhere to its policy of opening up to the outside world. In the current era of the rapid penetration of digital technology, China should make good use of the timeliness and convenience of digital technology to build a tourism service trade platform, so that China's excellent tourism products can enter the world's vision.

5.3. Limitations and Prospects

This paper conducts an in-depth examination of the relationship between the digital economy and tourism service trade. Although the study's findings enrich previous studies in the field to some extent, there are still some areas that need to be improved. In terms of the selection of the data period, the outbreak of COVID-19 at the end of 2019 impacted all industries in China, especially the tourism industry, resulting in many missing values and inaccuracies in much of data of 2020–2021. If the missing values are added to the current imperfect data processing method, the credibility of research results will inevitably improve. Therefore, this paper selects data from 2011 to 2019, although this time period is still relatively short. Future studies should go further and collect a more complete dataset on the digital economy and tourism service industry to obtain more accurate research findings. Further research should also focus on the development and changes in the relevant industries in the two years after the outbreak of COVID-19, collect complete data, and conduct a comparative analysis to explore the impact of COVID-19 on the digital economy and how it enables the tourism service trade. At the same time, as China's economy enters the stage of high-quality development, the index construction of the digital economy also needs to be dynamically adjusted.

This paper discusses the intermediary path of carbon emissions per capita, so will the digital economy affect the tourism service trade through other paths? Will these pathways be blocked by COVID-19? This is also worth considering in the future research.

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