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How the Internet Affects China's Green Consumption Development: Empirical Research Based on Baidu Index Data

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Abstract: Green consumption falls short in China's overall green economic and social transformation. There is a consensus to activate the potential of green consumption through the Internet. However, limited by the availability of green consumption data, few empirical studies focus on the impact of the Internet on green consumption. Based on the 2016–2020 Baidu Index of green consumption in 31 provinces and cities in China, this paper uses a fixed effect model with Driscoll-Kraay standard errors to assess the impact of the Internet on China's green consumption development and its impact mechanism. The results showed that improved Internet access capability and the development of the e-government play a significant role in promoting green consumption. The former helps to reduce the cost of consumers' information acquisition, while the latter helps to strengthen market supervision and improve the market environment. E-commerce has a significant negative impact on the development of green consumption, mainly because the existing e-commerce model is not conducive to the development of consumer trust. The impact of digital payment is not significant. Therefore, to achieve multi-governance and improve the Internet by activating green consumption, government departments need to promote the innovation of marketing models and strengthen the platform's supervision.

Keywords: internet access and utilization; green consumption; Baidu Index; e-commerce; FE model with Driscoll-Kraay standard errors

Citation: Peng, J.; Li, K.; Gao, Y. How the Internet Affects China's Green Consumption Development: Empirical Research Based on Baidu Index Data. *Sustainability* **2023**, *15*, 50. https://doi.org/10.3390/su15010050

Academic Editor: Ting Chi

Received: 22 November 2022
Revised: 15 December 2022
Accepted: 19 December 2022
Published: 20 December 2022

1. Introduction

In recent years, the concept of green/low-carbon consumption and environmental protection has been quietly gaining ground in China. According to the Sustainable Urban Development Boosting Consumption Upgrading report released by PricewaterhouseCoopers in July 2022, green consumption has been widely recognized by Chinese society in the areas of food, clothing, housing, transportation use, and tourism, and the scale of the green consumption market is growing rapidly. However, green consumption failed to keep up with the pace of green production transformation, which has restricted the overall economic and societal green transformation. The negative impact caused by expanding the scale of consumption offsets the improvement in green efficiency on the supply side [1]. With the proposal of a carbon peak in 2030 and carbon neutrality in 2060, accelerating the green/low-carbon consumption potential and expanding green consumption in high-quality economic developments have become prominent areas of focus.

With the gradual increase in the integration of the Internet and industry, the digital economy has become a new engine for China's economic development [2]. The accelerated application of Internet technology has spawned a large number of new business forms and models, which have led to great changes in China's production, circulation, consumption, and other fields and have largely affected residents' green consumption behavior. The advantages of Internet consumption, such as mitigating the space–time barrier of purchases,

reducing information asymmetry, and improving the efficiency of consumer information matching, have brought new opportunities for green consumption [3–5]; however, the biased technological progress of Internet technology has widened the "digital divide," and the spatiotemporal segmentation and concealment of Internet transactions have also affected green consumption [6]. What impact does the use and popularization of the Internet in China have on the development of green consumption? What is the specific mechanism by which the Internet affects green consumption? An in-depth discussion of these issues will not only help to clarify the obstacles faced by Internet technology in promoting green consumption development, but it will also guide the government in optimizing green consumption stimulus policies.

However, the difficulty in obtaining green consumption data has always been a crucial problem. Since 2006, Baidu has provided a Baidu Index that can reflect a user's search trends based on the search volume of netizens in Baidu and various keywords as statistical objects. Since then, Baidu has often been used in the analysis and prediction of the consumer confidence index, consumer price index (CPI), and other macro indicators. As consumers search for and understand the goods or services they want to buy before making green consumption decisions, the search index can reflect consumers' consumption behavior to a certain extent, helping us capture up-to-date consumer information that cannot be reflected by some traditional statistical indicators. In addition, due to the differences in economic development and the consumption environment, consumers' preferences and concerns will be different in different cities, and the Baidu Index can also reflect regional differences in green consumption. Based on green consumption data from mainstream e-commerce platforms, we selected representative products from currently popular areas of green consumption, such as food, housing, and transportation. Subsequently, we calculated the green consumption scores of each province and city based on the Baidu Index of representative products, the proportion of consumption expenditure of different products, and the carbon emission reduction potential to reflect the development of green consumption.

Considering the multi-faceted effects of the Internet on green consumption, this study constructs a multidimensional Internet development analysis framework and a green consumption evaluation index system, including food, housing, and transportation, to assess how Internet use affects the development and mechanisms of China's green consumption. Unlike previous studies, this study divides Internet development into two dimensions—access and utilization—and considers mobile Internet popularization, e-commerce, digital payment, and the e-government while also incorporating income thresholds, high information asymmetry, obvious moral attributes, and outstanding externalities. The impact of the Internet on green consumption is divided into four effects—income, information channel, social demonstration, and regulatory effects—and the impact of the Internet on green consumption is comprehensively analyzed. Using the Baidu Index, a more objective evaluation system is established. Owing to the wide range of green consumption, including many products, and the lack of authoritative statistical data, it is difficult to obtain green consumption data, which has always been a problem in evaluating the development of green consumption. Baidu is the largest search engine in China and the main tool used by consumers to search for and obtain information.

The paper is organized as follows: In the introduction, the importance of green consumption and the potential influence of the Internet on green consumption development are briefly introduced. The literature review introduces the definition of green consumption and its particularity and then analyzes the possible influencing mechanisms of the Internet on green consumption. The third part demonstrates the data source, variable setting, and empirical model in detail, especially the calculation of the comprehensive score of green consumption in 31 provinces and cities in China and the level of Internet development. The next section includes the results of the empirical analysis, including the results of the model test, regression, robustness test, and their possible limitations. The conclusion part summarizes the main conclusions, contributions, and implications for the government.

2. Literature Review

2.1. Green Consumption and Its Role in Green Economic and Social Transformation

The concept of "green consumption" originated from the Green Consumption Guide [7], which identifies products purchased by consumers that will not waste resources, pollute the environment, or harm human health and national development. Green consumption requires people to maintain an organic balance between human beings and the environment in the process of meeting their own needs [8]; this is an environmentally friendly consumption mode [9–11]. With ongoing research, the concept of green consumption has also increased. Carlson et al. (2008) [12] expanded this concept from purchase to use and subsequent disposal. More specifically, purchasing green organic food and eco-friendly products, conserving energy and water resources, recycling waste by category, taking public transport, buying hybrid cars, consuming less gasoline, using energy- and water-saving technology products (such as LED lights, low-flow shower nozzles, etc.) and installing solar water heaters and photovoltaic panels can be regarded as green consumption [13–15].

In addition to reducing carbon emissions [16], green consumption can also have a "downstream effect," forcing producers to implement greener production and packaging methods, thereby reducing resource input in upstream production links and leading enterprises in low-carbon innovation and industrial upgrades [17–19]. Taking food waste as an example, Yue et al. (2013) [20] analyzed the influence of green consumption behavior on the production and supply system and pointed out that reducing food waste could alleviate the shortage of arable land and water resources in China, increase domestic supply, and ease the pressure of rising food prices. Chen and He (2020) [21], based on a simulation of overlapping models of time, pointed out that the growth of green consumption promotes the expansion of green production, which can reduce poverty while improving environmental quality and public health, and achieve green development and improved social welfare.

2.2. Characteristics of Green Consumption and Its Influencing Factors

However, compared with the traditional consumption mode, green consumption has the following characteristics:

First, green consumption has a higher income and economic development threshold [22]. The high price of green seafood has hindered consumers' green consumption behavior [23]. Based on a survey of consumers' willingness to pay for eco-labeled seafood implemented in France, Lucas et al. (2018) [24] found that consumers with higher incomes (2400 euros/month and above) were more willing to engage in green consumption. Yan et al. (2019) [25] found that the middle class was more inclined toward green consumption.

Second, there is also serious information asymmetry in the green consumption market, which makes it difficult for consumers to perceive the "green attributes" of products directly, which not only easily leads to market failure but also gives green consumption a stronger moral component [8,26]. Tezer and Bodur (2020) [27] found that the low degree of environmental protection of a product's green attribute will hinder consumers' green consumption behavior. As a result, consumers with higher education and rich environmental knowledge are more likely to engage in green consumption [28–30]. Diekmann and Theuvsen (2019) [31] indicated that pleasure is an important factor for consumers to turn to greener communities to support agriculture. They found that consumers using green products can improve their sense of social value and ultimately increase their sense of pleasure in the consumption process [27].

Lastly, green consumption also has significant environmental externalities, so a more complete legal system, regulatory standards, and policy system for green consumption are needed to mitigate inconsistencies between the individual costs and social costs of green consumption [32,33]. The green consumption model relies on changes in social norms and consumption habits [34]. Adopting public policies to encourage people to consume green is a key issue for achieving a sustainable society in the future. Bezin (2019) [35] built a structural model of the interaction between green consumption and green technology and

verified that public policies such as pollution tax and environmental education can shorten the green consumption transformation process.

2.3. The Impact of the Internet on Green Consumption

Nowadays, the Internet has deeply penetrated all aspects of production and life, largely reshaping the consumption modes of residents. Although few empirical studies are focusing on the impact of the Internet on green consumption, summarizing its impact on consumption can still inspire us in terms of impact mechanisms.

2.3.1. Income Effect

The application of the Internet and big data technologies has effectively stimulated the market vitality of data resources, improved the allocation efficiency of traditional production factors such as labor and capital, optimized resource allocation, and brought about an increase in the income of urban and rural residents [36,37]. On the other hand, with the rapid rise in e-commerce based on Internet technology, not only does the scale effect of e-commerce platforms effectively reduce the marketing cost of products, but it also intensifies market competition for products and drives down their prices [38,39]. In addition, the rapid development of digital payment options, with their higher convenience and availability, has helped ease the credit constraints on consumers [40–42].

At the same time, the existence of the digital divide (i.e., the gap between Internet access ability and utilization ability) may also lead to a widening of the income gap between urban and rural areas, different groups, and different classes [43], hindering upgrades to the urban and rural consumption structure, and restricting improvements to the green consumption market capacity [44]. Moreover, with increasingly fierce online market competition and the transformation of e-commerce, the disadvantages of vulnerable groups such as small farmers and producers are gradually exposed, and their market relationship with the Internet is gradually broken [45], which may also lead to the widening of the income gap between different classes.

2.3.2. Information Channel Effect

The Internet's more efficient dissemination of information and utilization capability have widened the market boundaries of consumption. Traditional offline consumption is still limited to a specific time and space. In the context of "Internet plus," the realization channel of consumption has changed from a single front-line offline platform of the traditional economy to a multi-channel platform [46]. Moreover, the interactive platform built by the Internet for both buyers and sellers helps achieve direct contact between the supplier and consumer, reduces the cost of information communication, supervision, and information search engines, improves the matching efficiency of supply and demand information, and reduces information asymmetry in the market [47]. Online transactions will also help alleviate information asymmetry problems that can be associated with a multiple-platform economy [48].

The characteristics of Internet transactions, however, such as the spatiotemporal division, virtual nature of transactions, and concealment of transactions [49], have greatly increased transaction uncertainty, causing consumers to face the simultaneous uncertainty of Internet platforms, transaction partners, and purchase outcomes [50], which makes it more difficult to establish trust in online transactions.

2.3.3. Social Demonstration Effect

E-commerce online reviews and Internet social media play an important role in consumption behavior, and consumers rely on this information to make consumption decisions [51]. However, the growth of social media has also provided conditions for the widespread use of negative comments and information. The Internet has accelerated the spread of negative information, expanded the scope of information dissemination, increased risk occurrence and uncertainty, and amplified negative events. In addition, with

the gradual popularization of e-commerce and digital payments, excessive and impulsive consumption has become more common [52].

2.3.4. Regulatory Effect

The application of Internet technology provides conditions for the innovation of consumption supervision and multi-governance realization. The Internet has improved communication efficiency between departments, provided possibilities for cross-regional regulatory cooperation, promoted regulatory process re-engineering, reduced the time and cost of regulatory coordination, and made management more efficient [53,54]. Based on Internet big data, more efficient consumption risk detection and early warning tools can be built to promote diversification, strategy, and refinement of regulatory means, as well as strong responsiveness and incentives. The multiple communication means of the Internet help to achieve efficient interaction among the government, business entities, and consumer entities, integrate non-governmental organizations with social forces and consumers, transform the traditional "top-down supervision model" into a "governance model" of interaction, and build a social co-governance situation whereby the government, market, and social forces are integrated. However, at the same time, the application of Internet technology, as well as the new model and business format formed on this basis, highlights the problems of the current regulatory mode characterized by territorial management and command control.

Therefore, according to the characteristics of green consumption and the impact mechanism of the Internet on consumption, we believe that the impact of the Internet on the development of green consumption is therefore very complex, including not only the direct impact on consumption but also the impact on upstream production links and even the entire industrial chain; it includes not only the direct impact on the decision-making of market players but also the impact on market supervision and the consumption environment. It is, therefore, necessary to establish a more systematic analysis framework that includes the multi-level and multidimensional nature of the Internet. Thus, based on the hierarchical division standard of the digital divide, this study divides the impact of the Internet into two dimensions: access and utilization (Figure 1). The former focuses more on the impact of the Internet on consumer information acquisition and household resource allocation, while the latter focuses on the Internet's influence on business, finance, and government affairs to investigate the impact of the Internet on green consumption comprehensively.

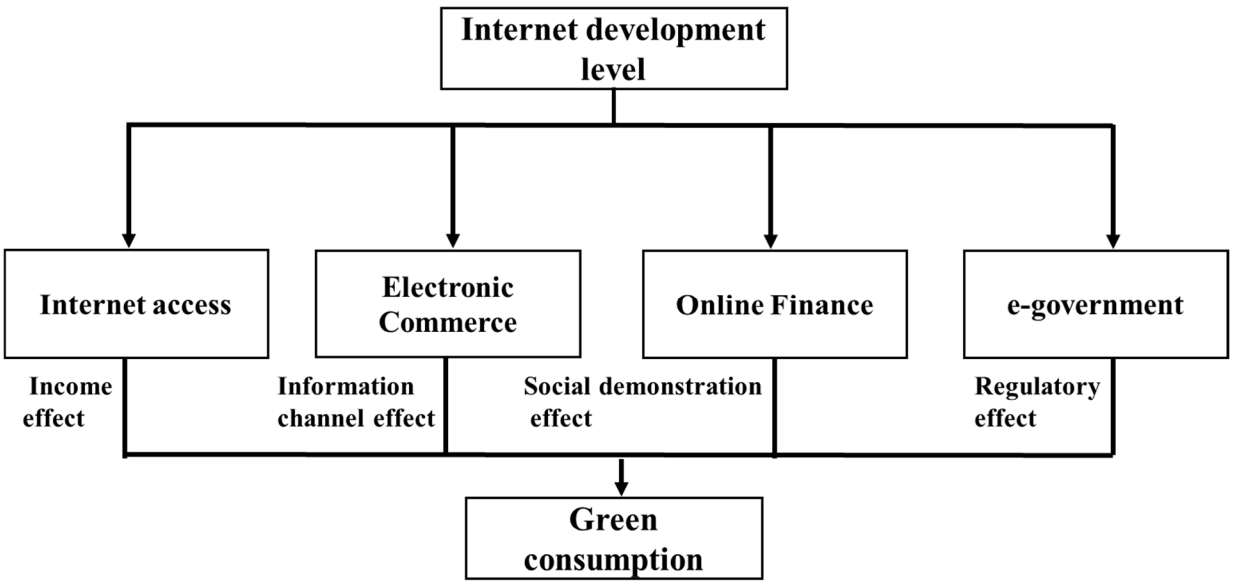

Figure 1. The impact mechanism of the Internet on China's green consumption.

3. Materials and Methods

3.1. Data Sources and Processing

The research data used in this study came from the statistical yearbook, Baidu Index, microblog public opinions, and other channels, including three main aspects. First, in combination with the green commodity sales of the JD and Alibaba e-commerce platforms, representative products were selected from four fields: food, housing, daily necessities, and travel. The Baidu Index of representative products from 31 provinces and cities is selected through data mining to measure the green consumption willingness of residents in various regions. A proportion of the top 100 cities in the province's government microblog sphere of influence is chosen to represent the development level of the e-government in each province. Finally, other data are taken from the China Statistical Yearbook and provincial statistical yearbooks.

3.2. Variable Settings

3.2.1. Green Consumption

The level of green consumption was expressed as the comprehensive score of green consumption in each province. According to the 2017 Report on Chinese Residents' Consumption, the Implementation Plan for Promoting Green Consumption, and the green consumption reports released by Alibaba, JD, and other e-commerce platforms (e.g., JD's 2019 Green Consumption Trend Development Report and Alibaba's 2016 Report on China's Green Consumers), the product categories with high green consumption enthusiasm were targeted: food, home decoration, and building materials, household appliances, and daily necessities. There are four first-level indicators for travel. On this basis, representative products were selected from four fields: food, housing, daily necessities, and transportation (Table 1). Owing to the lack of actual sales data for green products, the Baidu Index of green products from 2016 to 2020 was selected as the indicator to evaluate the development of green consumption. The Baidu Index was used because it is based on the search volume of Internet users in Baidu, uses keywords as the statistical objects, and scientifically calculates the weighted sum of the search frequency of each keyword in Baidu webpages, which can reflect the "user attention" of different keywords in previous periods. Therefore, Baidu search data can accurately reflect the green consumption intentions of Chinese residents. Finally, after determining the Baidu Index of various green products in 31 provinces and cities from 2016 to 2020, combined with the proportion of residents' food, housing, daily necessities, and travel expenses and the proportion of energy consumption per 10,000 yuan of these products (the results of the 2020 GCC Task Force are cited here). Energy consumption per unit of expenditure on food, tobacco, alcohol, clothing, housing, daily necessities and services, communications, education, culture and entertainment, health care, other supplies, and services was 122.44 kg/10,000 yuan, 170.99 kg/10,000 yuan, 125.19 kg/10,000 yuan, 166.80 kg/10,000 yuan, 220.61 kg/10,000 yuan, 138.73 kg/10,000 yuan, 201.22kg/10,000 yuan, and 147.71 kg/10,000 yuan, and the final weighted comprehensive score of green consumption in each province was calculated.

3.2.2. Internet Development Level

Based on the above two-dimensional analysis of the impact of Internet access and use on green consumption, the number of mobile Internet users is selected to represent Internet access capability, e-commerce, and digital finance. The three indicators of e-governments represent the Internet utilization capacity (expressed by online retail sales, the number of Taobao villages, the digital inclusive financial payment index, and the proportion of the top 100 cities in the government microblog ranking, respectively (see Table 2 for details)).

Table 1. Green consumption level evaluation index and weight setting (data source: Baidu Index).

Green Consumption	Level I Indicators	Secondary Indicators	Expenditure Weight	Energy Consumption Intensity Ratio (Relative to Energy Consumption in All Categories)
A comprehensive score on green consumption	Food	• Organic vegetables • Organic fruit • Organic rice • Organic milk • Organic milk powder	The proportion of household food expenditure	The ratio of energy consumption to food expenditure per 10,000 yuan (9.46%)
	Home decoration building materials	• Environmentally friendly cabinets • Environmentally friendly paint	The proportion of residential expenditure in resident consumption expenditure	The proportion of energy consumption per 10,000 yuan of residential expenditure (9.68%)
	Household appliances and articles for daily use	• Recycled paper • Recycled plastics • Energy-saving lighting • Energy-efficient household appliances	The proportion of household expenditure on living goods and services	Energy consumption per 10,000 yuan for daily necessities and services (12.89%)
	Travel	• Hybrid vehicles • New-energy vehicles	The proportion of household transportation and communication expenditures	The proportion of energy consumption from transportation and communication expenditures per 10,000 yuan (17.05%)

Table 2. Internet Development Level Indicator System.

Level I Indicators	Secondary Indicators	Measurement Method	Data Sources
Internet access	Broadband and Mobile Internet Access	Number of mobile Internet users	China Statistical Yearbook
Internet utilization	Electronic Commerce	Online retail sales	China Statistical Yearbook
		Number of Taobao villages	Research Report on Taobao Village in China
	Online Finance	Digital inclusive financial payment index	Peking University Digital Inclusive Finance Index
	E-government	The proportion of the top 100 cities in the government microblog ranking	Government Microblog Influence Report

3.2.3. Control Variables

Based on existing research on the Internet, household consumption, green consumption drivers, and other related factors, this study selects the following control variables (Table 3). (1) GDP per capita: green products often have a higher market premium, so they are more dependent on the income of residents. (2) Engel coefficient: the lower the Engel coefficient, the lower the proportion of food consumption in household consumption. Consumers' demand for food changes from satiety to eating well and healthily, and the demand for green consumption increases. (3) Urbanization: generally, the higher the degree of urbanization, the stronger the residents' consumption ability, the better the consumption structure, and the higher the level of green consumption development. (4) Total dependency ratio: this is measured by the ratio of the non-working-age population to

the working-age population. The higher the dependency ratio between the elderly and children, the greater the pressure on household expenditures, and green consumption may be restrained. (5) Sex ratio: this is measured by the number of men corresponding to every 100 women, and existing research shows that women have a higher degree of recognition of green consumption; therefore, the higher the gender ratio, the more difficult it is to develop green consumption. (6) Consumer price index: generally speaking, the higher the consumer price index, the higher the cost of green products.

Table 3. Variables and descriptive statistics.

Control Variables	Variable Interpretation	Mean Value	Variance
Green consumption level	A comprehensive score of green consumption	7313.819	4315.978
Number of mobile Internet users	Number of mobile Internet users (Ten million)	4096.257	2840.771
Online retail sales	Refers to the sum of retail sales of goods and services realized through public online trading platforms (including self-built websites and third-party platforms) (100 million yuan)	2793.096	4513.628
Number of Taobao villages	Number of Taobao villages (quantity)	105.5871	269.2637
Payment Index	Digital financial payment uses an index	260.239	44.289
e-government	The proportion of the top 100 cities in the government microblog ranking (%)	3.518	17.675
GDP per capita	The national GDP divided by the country's total population (Yuan)	64,579.42	29,477.67
Engel coefficient	The ratio of food expenditure to total consumption expenditure (%)	29.535	4.223
Urbanization rate	Urban population proportion (%)	61.396	11.619
Total dependency ratio	The ratio of the non-working-age population to the working-age population (%)	39.993	6.753
Sex ratio	Number of males per 100 females	104.735	4.119
Consumer price index	The total consumer price index of the provinces	102.118	0.587

3.3. Model Construction

The impact model of the Internet on the development of green consumption is as follows:

$$Lsxf_{i,t} = \alpha_0 + \alpha_1 Hlw_{i,t} + \alpha_c Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \quad (1)$$

In Formula (1), $Lsxf_{i,t}$ is the green consumption level of the province and city i in period t, $Hlw_{i,t}$ is the related variable of the Internet development level of the city i in period t, and the vector $Z_{i,t}$ represents a series of control variables. The term μ_i represents the individual fixed effect of city i that does not change with time, δ_t controls the time-fixed effect, and $\varepsilon_{i,t}$ represents the random disturbance term.

4. Results and Discussion

4.1. Model Evaluation

First, the individual effect was tested to determine whether there is heterogeneity in the cross-regional flow of food safety risks among different cities. The hypothesis that there is no individual effect in the model was rejected at the 1% level (the Individual effect test in Table 4). Therefore, compared with the mixed model, the fixed-effect model or random-effect model is more suitable.

Table 4. Model Evaluation Results.

Individual Effect Test	Hausman Test	Autocorrelation Test		Heteroscedasticity Test
		Cross-Section Autocorrelation	Sequence Autocorrelation	
F (30, 113) = 3.75 Prob > F = 0.000	χ^2 (8) = 17.04 Prob > χ^2 = 0.0297	Friedman's test Prob = 0.8564	F (1, 30) = 31.085 Prob > F = 0.000	χ^2 (31) = 1855.53 Prob > χ^2 = 0.0000

Then, the Hausman test was conducted to choose the fixed-effects model or the random-effects model. If μ_i and $x_{i,t}$ are relevant, the fixed-effect model should be selected; otherwise, the random-effect model should be selected. The Hausman test results (the Hausman Test in Table 4) disproved the hypothesis that individual effects were not related to the explanatory variables at the 5% level (Prob > χ^2 = 0.0297), indicating that the fixed-effect model was better.

After the fixed-effect model was selected, further autocorrelation and heteroscedasticity tests were conducted (the Autocorrelation test and Heteroscedasticity test in Table 4). Cross-section autocorrelation tests show that there is no cross-section correlation problem, and sequence correlation test results show that there is sequence correlation. The results of the heteroscedasticity test showed that the model had significant heteroscedasticity problems. Therefore, the fixed effect model with Driscoll-Kraay standard errors was adopted to correct autocorrelations and heteroscedasticity. At the same time, the regression results of the cluster robust standard error model were added for comparison to confirm the robustness of the results (Table 5).

Table 5. Empirical Regression Results.

Green Consumption Level	Fixed Effect Model (1)		Fixed Effect Model with Cluster Robust Standard Error (2)		Fixed Effect Model with Driscoll-Kraay Standard Errors (3)	
	Coefficient	Std. Error	Coefficient	Steady Std. Error	Coefficient	Driscoll-Kraay Std. Error
Number of mobile Internet users	2.073 ***	0.396	2.073 ***	0.411	2.073 **	0.535
Online retail sales	−0.501 ***	0.183	−0.501 ***	0.212	−0.501 **	0.164
Number of Taobao villages	−1.008	1.681	−1.008	2.008	−1.008	2.550
Payment Index	−19.222	14.971	−19.222	22.045	−19.222	10.511
e-government	939.807	683.438	939.807 **	446.899	939.807 **	279.118
GDP per capita	−0.017	0.022	−0.017	0.026	−0.017	0.013
Engel coefficient	−203.592 **	84.669	−203.592 **	91.596	−203.592 **	57.091
Urbanization rate	14.844	171.116	14.844	213.079	14.844	1.289
Total dependency ratio	−52.123	61.135	−52.123	44.3	−52.123	53.205
Sex ratio	−24.835	50.72	−24.835	34.673	−24.835	17.511
Consumer price index	−1171.746 ***	259.788	−1171.746 ***	277.403	−1171.746 **	258.423

Table 5. *Cont.*

Green Consumption Level	Fixed Effect Model (1)		Fixed Effect Model with Cluster Robust Standard Error (2)		Fixed Effect Model with Driscoll-Kraay Standard Errors (3)	
	Coefficient	Std. Error	Coefficient	Steady Std. Error	Coefficient	Driscoll-Kraay Std. Error
Constant term	132,593.72 ***	25,963.721	132,593.72 ***	27,088.113	132,593.72 ***	25,073.43
F-test	13.745		26.966		200.42	
Prob > F	0.000		0.000		0.0001	

Note: *** and ** are respectively significant at 1% and 5% levels.

4.2. Analysis of Empirical Results

The data analysis above indicates that Internet access (i.e., the number of mobile Internet users) significantly affects green consumption. With the deepening of Internet infrastructure construction, China's Internet penetration rate has been increasing, and the Internet access gap has been narrowing. The 50th Statistical Report on the Development of Internet in China shows that, by June 2022, the number of Internet users had reached 1.051 billion, the Internet penetration rate had reached 74.4%, and rural areas had also achieved "broadband access to villages." In terms of the mobile Internet, 99.6% of Internet users use mobile phones to access the Internet. On the one hand, the improvement in Internet access capability has given consumers stronger information-retrieval capabilities, reduced information-retrieval costs, reduced the degree of information asymmetry in the green product market, improved the matching efficiency of supply and demand in the green product market [55], and promoted the development of green consumption. On the other hand, the increase in Internet penetration has also created conditions for increases in residents' income, improved the allocation efficiency of traditional production factors such as labor and capital, and improved the human capital of residents, thus easing the inhibition of the high-income threshold on the development of green consumption [36,37].

The use of the Internet in different fields, namely e-commerce, digital payments, and e-governments, has had a heterogeneous impact on the development of green consumption. Specifically, online retail sales significantly negatively affect the development of green consumption, while the impact of the number of Taobao villages is also negative but not significant. This shows that, although the supply of online green products continues to increase and online channels have gradually become an important channel for green consumption, the development of e-commerce has inhibited the realization of green consumption. This relates to the information presentation and interaction characteristics of traditional e-commerce models. Traditional e-commerce primarily displays information related to green products in words, pictures, and videos. This method is relatively simple, and the information flows in one direction; consumers and businesses lack effective interaction [56]. These characteristics not only restrict the solution to the problem of information asymmetry in the green consumer market but also hinder the establishment of consumer trust [57]. At the same time, sellers' order stealing and comments on counterfeiting, incorrect versions of goods, and the proliferation of counterfeit-featured products also detract from consumers' trust in green product e-commerce [58], restricting the growth of green consumption. The traditional e-commerce model has difficulty meeting the requirements of the diversified value output of green consumption. Green consumption has a distinct "display" attribute. In the green consumption process, consumers not only require products to have basic practical functions but also require the outward demonstration of ecological, cultural, and other diverse values. The traditional e-commerce model, therefore, has difficulty meeting consumers' needs [59].

Digital payments had no significant impact on green consumption. Although digital payment has greatly improved the convenience of green consumption, it also has traceability, which is conducive to stimulating consumers' willingness to consume. However,

whether consumers are willing to buy green products depends on their satisfaction with both the products and the shopping process. In both e-commerce platforms and offline channels, the current positive incentives for green consumption are more similar to programs such as Alipay's "green energy," exposing the limitations of the current system [60,61]. The development of digital payments, especially Internet consumer credit represented by Huabei, has also stimulated consumers' irrational, impulsive, and excessive consumption to a certain extent [62,63]. In general, digital payments have not played a positive and significant role in the development of green consumption.

E-governments positively affected green consumption, which was significant at the 5% level. E-governments, especially through the Internet, can effectively restrain the restriction of online sales on green consumption due to their spatiotemporal segmentation and strong concealment. First, government microblogs provide more efficient and reliable publicity for green products. The government microblog provides a new channel for the promotion of green products and their related certifications and brand information. In addition, the trusted endorsement of government microblogs also increases the credibility of the information, thus enhancing consumers' trust in green products. Second, the microblogging platform has realized efficient interaction between the government and market subjects, forcing the government to optimize the green consumption management process and encouraging business environment optimization and green consumption growth [64,65]. Finally, the government microblog provides a more direct information exchange platform and service platform, enabling consumers' evaluations of green products, especially negative evaluations, to be directly submitted to regulatory authorities, reducing consumers' rights protection costs and improving consumers' trust in green products [66,67].

In terms of control variables, the Engel coefficient and consumer price index have significant negative effects on green consumption. The lower the Engel coefficient, the lower the proportion of food consumption in overall household consumption expenditure. Consumers' demands for food consumption shift from having enough food to eating well and eating healthily. The emphasis on safety and health makes such consumers more willing to pay extra premiums for environmentally friendly production methods, because the ecological environment has a direct impact on product safety and quality, showing the spillover effect of health motivation. The impact of the CPI on green consumption is also negative. An increase in the CPI further increases the cost of purchasing green products, and green products have a higher premium than traditional products do, thus restricting the demand for green products. In contrast, the CPI can also reflect whether the Internet can effectively improve the level of market consumption competition. A high CPI means that the Internet has failed to make the suppliers of green products reduce their product prices or make them actively provide more product information to gain a competitive advantage.

4.3. Robustness Test

To test the reliability and robustness of the results of Internet access, e-commerce, and e-governments' effects on the development of green consumption, this study replaces core variables.

First, we replaced the number of mobile Internet users with the number of broadband users to test the robustness of the impact of Internet access (Table 6 for Internet access). The results show that the number of broadband users also has a significant negative impact on green consumption, which proves that Internet access capability, especially the narrowing of the access gap, plays an important role in promoting green consumption. Then, by replacing online retail sales with e-commerce sales, the results show that the negative impact of e-commerce sales on green consumption is significant at the 10% level, which also proves the robustness of the above results (Table 6 for e-commerce). Finally, we replace the proportion of cities with the number of cities ranking in the top 100 in microblog government affairs. Compared with previous results, although the coefficient decreased significantly, e-governments still had a positive impact on the development of green consumption (see Table 6 for e-governments).

Table 6. Robustness Test.

Internet Access Variable Replacement		e-Commerce Variable Replacement		e-Government Variable Replacement	
Number of broadband users	1.937 * 0.740	Number of mobile Internet users	1.790 ** 0.464	Number of mobile Internet users	2.133 ** 0.517
Online retail sales	−0.258 * 0.109	E-commerce sales	−0.207 * 0.095	Online retail sales	−0.520 ** 0.157
Number of Taobao villages	−2.901 1.750	Number of Taobao villages	−3.591 1.687	Number of Taobao villages	−0.643 2.420
Payment Index	−22.915 11.564	Payment Index	−28.039 ** 7.643	Payment Index	−19.222 10.511
e-government	968.549 ** 288.950	E-government	995.274 ** 237.833	E-government	199.171 94.628
GDP per capita	−0.045 0.011	GDP per capita	−0.018 0.016	GDP per capita	−0.014 0.012
Engel coefficient	−236.757 *** 49.906	Engel coefficient	−210.063 ** 49.922	Engel coefficient	−203.592 ** 57.091
Urbanization rate	203.310 148.142	Urbanization rate	93.979 60.430	Urbanization rate	13.503 62.960
Total dependency ratio	−49.139 57.166	Total dependency ratio	−30.740 42.279	Total dependency ratio	−67.155 46.405
Sex ratio	−31.612 16.226	Sex ratio	−32.117 23.988	Sex ratio	−34.566 22.296
Consumer price index	−1415.312 ** 475.606	Consumer price index	−1157.893 ** 255.126	Consumer price index	−1227.382 *** 245.949
Constant term	155,592.346 ** 43,592.12	Constant term	129,631.2 *** 25,070.65	Constant term	141,777.5 *** 24,539.82
F-test	13.745	F-test	11.53	F-test	6.81
Prob > F	0.000	Prob > F	0.0152	Prob > F	0.0394

Note: ***, ** and * are respectively significant at 1%, 5% and 10% levels.

4.4. Summary

From the results of the empirical analysis, the Internet can simultaneously promote and inhibit the development of green consumption. On the one hand, improved internet access capability and the development of e-governments can effectively promote the development of green consumption. This is because the Internet, as an efficient information transmission tool, helps reduce the degree of information asymmetry between consumers, enterprises, and the government, and improves the efficiency of market supply and demand matching. It also promotes improved market supervision ability. On the other hand, e-commerce has the opposite effect, as it inhibits the development of green consumption, which is mainly because the traditional product display mode of e-commerce and the interaction between buyers and sellers are not conducive to developing trust. In addition, although digital payment has a negative impact on green consumption, the impact is not significant.

5. Conclusions

Based on the panel data of 31 Chinese provinces and cities from 2016 to 2020, including the Baidu Index, ongoing public opinion on Weibo, JD, and Alibaba, and other platform-related provincial and municipal data, this study used the fixed effect model with Driscoll-Kraay standard errors to examine the impact of the Internet on the development of green consumption in China. The main conclusions of this study are as follows: First, the popularity of the Internet and the improvement of access capability have significantly promoted the development of green consumption in China, and this result has passed

a series of robustness tests. Second, because the traditional e-commerce information presentation mode and output value are singular, and the lack of effective interaction with consumers leads to consumers' lack of effective trust in the green products of e-commerce platforms, the development of e-commerce not only does not promote the development of green consumption but also plays a restraining role. Third, the convenience and traceability of digital payments have not significantly promoted the development of green consumption, because digital payment is often tied to e-commerce, and it is difficult to solve the traditional e-commerce trust issues by relying on digital payment alone; to a certain extent, this has encouraged irrational consumption. Fourth, the e-government plays a significant role in promoting the development of green consumption. Its efficient and authoritative information release and more efficient interaction with consumers help reduce the cost of information retrieval and consumer rights protections, optimize the market environment for green consumption, and promote the development of green consumption.

The first contribution of this paper lies in the use of the Baidu Index, which provides a new idea for overcoming the problem of obtaining green consumption data. As green consumption involves all aspects of life, including food, clothing, housing, transportation, and both the purchase of green products and the use and recycling of products, it is difficult to collect data from traditional sources, such as the sales platform or government statistical data. The difficulty in obtaining green consumption data has always been a problem in the evaluation of green consumption development. The Baidu Index is derived from the search records of consumers, which can help us capture the latest dynamic information on green consumption in various fields and links. Secondly, with the deep integration of the Internet with production, life, and even government supervision, the functions of the Internet are increasingly enriched. Therefore, it is inevitable that there are errors in investigating its impact on green consumption based on certain Internet tools. Therefore, this paper not only draws on the concept of the digital divide and examines the impact of the Internet on green consumption by considering Internet access, e-commerce, e-governments, and digital payment, but it also assesses the difference in the effects of the Internet on the development of green consumption.

These empirical results may provide some implications for the government. First, the government should further improve the universal access capability of the Internet, promoting the Internet's extensive and in-depth penetration into various fields of economic, social, and industrial development, and driving the long-term growth of China's green consumption. Second, the government needs to improve the policy system, provide a good green and low-carbon participation platform for the public, promote innovation in the green consumption marketing model, strengthen the management of Internet e-commerce platforms, urge each e-commerce platform to revise and upgrade the traditional e-commerce model, improve the readability and visualization of green consumption information on various platforms, increase the e-commerce traceability, and broaden the consumption channels of green behavior. Third, the government should actively promote e-government platforms and supply green consumer products and information through various government platforms.

This study also has some limitations. First, due to incomplete Internet statistics, this study only selected provincial data from 2016 to 2020, with a total of 155 samples. Although the existing results are sufficiently robust, the small number of samples prevents us from including variables that can directly reflect the income effect, information channel effect, and other intermediary mechanisms into the regression model for a separate analysis of the Internet's role mechanism. Therefore, with the accumulation of Internet data, it is particularly necessary to use longer panels or use city and county-level data to build larger samples to test the mechanism of the Internet. Second, although this paper finds that e-commerce has an inhibitory effect on green consumption, e-commerce models are also constantly innovating. Therefore, if we can filter the e-commerce indicators, such as clarifying the differences in the e-commerce sales of different models and industries, it will

be more conducive to promoting the standardized development of e-commerce, to better stimulate the demand for green consumption.

Author Contributions: Conceptualization, K.L. and J.P.; methodology, K.L.; software, K.L.; validation, J.P., K.L. and Y.G.; formal analysis, K.L.; investigation, J.P.; resources, Y.G.; data curation, K.L.; writing—original draft preparation, J.P.; writing—review and editing, K.L.; visualization, Y.G.; supervision, J.P.; project administration, K.L.; funding acquisition, J.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Zhejiang Provincial Philosophy and Social Sciences Planning Project (grant number 22NDJC336YBM), the National Social Science Fund of China (grant number 19ZDA106; 20CGL027), and the Fundamental Research Funds for the Provincial Universities, Zhejiang Institute of Economics and Trade (grant number 22SBYB03).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data used in this manuscript are provided by government agencies and Baidu Index.

Conflicts of Interest: The authors declare no conflict of interest.

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