

Article

An Empirical Study on How Livestreaming Can Contribute to the Sustainability of Green Agri-Food Entrepreneurial Firms

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Abstract: During the COVID-19 pandemic, digital technology has been used in all aspects of the agricultural field. How to seize the opportunity to achieve the production-marketing connection is increasingly becoming a top concern for green agri-food enterprises. Based on the theory of a task–technology fit, this study analyzes the fitness between livestreaming e-commerce and green agri-food. More specifically, the task characteristics cover the seasonality, locality, and eco-friendliness of green agri-food, and the technology characteristics cover the responsiveness, interactivity, and entertainment of livestreaming e-commerce. Using data of a sample of 574 green agri-food entrepreneurial firms collected through a web-based questionnaire, we perform structural equation modeling (SEM) analysis and find that the locality and eco-friendliness of green agri-food, the responsiveness, interactivity, and entertainment of livestreaming e-commerce have a positive effect on the fit of green agri-food livestreaming e-commerce. Moreover, the fit of green agri-food livestreaming has a positive effect on firm performance and the intention to adopt livestreaming e-commerce. This study also demonstrates that perceived corporate social responsibility has a moderating effect on the relationship between the fit of livestreaming of green agri-food and the intention to adopt livestreaming e-commerce. This study extends prior research on the task–technology fit into livestreaming e-commerce companies and provides insights into our understanding of successful adoption of livestreaming e-commerce.

Keywords: task–technology fit theory; green agri-food firm; livestreaming e-commerce; adoption; firm performance; corporate social responsibility



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1. Introduction

With the improvement in the consumption level and green consumption awareness, consumers began to prefer green agri-food [1,2]. However, due to the outbreak of COVID-19, field procurement vehicles could not enter the production area, which has hindered the traditional marketing model of ‘unified purchase of origin—transit in the farmer’s market—distribution to major supermarkets’. Therefore, offline sales of agri-food were prohibited in different regions to varying degrees. As a result, there had been increasing concerns regarding the production and marketing connection of agri-food.

Driven by the growth trend of livestreaming economy, many e-commerce platforms, short video platforms, social platforms, and other e-commerce companies are working hard on the livestreaming commerce. Nowadays, large plantation families are also using livestreaming commerce to broaden new marketing channels for agri-food. However, the livestreaming of agri-food is facing problems such as content homogeneity, vulgarity, and streamers with different educational backgrounds. To a certain extent, these issues have affected the consumers’ overall impression of the livestreaming of agri-food. In addition, they have a negative effect on the e-commerce companies’ sustainable livestreaming business. On the other hand, with the rapid development of e-commerce, many problems such as false sales and shoddy goods continue to appear. The waste and environmental

pollution caused by excessive packaging and the poor working environment of express workers have been gradually severe [3,4]. Therefore, the voices that require e-commerce companies to strengthen corporate social responsibility are becoming louder [5,6].

In the academic field, previous livestreaming studies mainly focused on user purchase decision [7–13], user participation [14–18], use motivation for livestreaming [19], customer relationship management under livestreaming [20], and livestreaming and marketing performance [21]. In the field of agri-food marketing and livestreaming adoption, no relevant research exists on livestreaming that promotes the marketing of agricultural products. Furthermore, in the study on CSR of e-commerce companies, in addition to urging the establishment of e-commerce compliance, improving the quality of e-commerce platform information and accelerating the construction of corporate ethics and ethics [20–23], there are still many deficiencies in the study on user perception of CSR. Therefore, our research is motivated to contribute to the literature related to the marketing of green agri-food and provides an answer to a question of whether livestreaming for agri-food marketing from the perspective of green agri-food firm level is appropriate. In addition, this study aims to evaluate the effectiveness of social responsibility in livestreaming e-commerce of green agri-food and provides a theoretical basis for the sustainable development of livestreaming e-commerce of green agri-food.

Our study offers three contributions to the literature. First, we provide a rigorously derived estimate of how various green agri-food attributes and livestreaming features may shape the overall degree of task–technology fit, which may in turn contribute to the intention of green agri-food entrepreneurial firms to adopt livestreaming e-commerce and their firm performance. By doing so, we provide an important contribution to the livestreaming research by identifying and empirically examining specific product- and technology/service-related features that influence the task–technology fit which then enables firms to adopt livestreaming e-commerce. Second, we examine how much stronger the relationship between task–technology fit and the intention of green agri-food entrepreneurial firms to adopt livestreaming e-commerce is when these entrepreneurial firms engage in more CSR activities. We thus offer preliminary evidence regarding the importance of implementing nonmarket strategies by identifying how the engagement of CSR shapes the potential effect of task–technology fit on the intention of green agri-food entrepreneurial firms to adopt livestreaming e-commerce. Furthermore, we contribute to the development of theory and methodology in the livestreaming e-commerce research by integrating product attributes, technology features, nonmarket strategic choices, e-commerce adoption, and firm performance and highlight a critical link between these bodies of research. We believe this study was one of the first efforts to develop and examine a structural equation modeling that connects various factors. Overall, we believe that this study may provide new insights on how to better motivate entrepreneurial firms to adopt livestreaming e-commerce and how to enhance their performance. We hope that our study can inspire future research to further investigate mechanisms that motivate entrepreneurial firms to adopt new service or platforms such as livestreaming e-commerce.

2. Literature Review and Hypothesis Development

2.1. Task–Technology Fit Theory

In 1995, Goodhue and Thompson proposed the TTF theory, which predicted the adoption of technology and performance through task characteristics, technical characteristics, and TTF [22]. According to TTF theory, the effect of new technology on performance depends on whether the technology used can fit the task to be completed, which reflects how important the TTF is in performance. Moreover, Goodhue and Thompson also emphasized that detailed information technology and user task can better reflect the corresponding relationship between technical performance and user needs.

In recent years, TTF theory has been widely used in the study of new technology adoption willingness, such as e-commerce, Internet of Things, AI, cloud mobile services, and so on [23–29]. TTF theory demonstrates a good explanatory capability in explaining

the TTF and technology adoption. This study uses TTF theory to explain and analyze the fit between the marketing characteristics of green agri-food and the technology of livestreaming e-commerce and to understand the effect of the fit on firm performance and intention to adopt. Considering that the livestreaming technology is provided by a third-party e-commerce company. The study adds CSR as a moderating variable based on the original TTF model framework to investigate how an e-commerce company would fulfill its CSR by livestreaming green agri-food. Figure 1 presents the theoretical model upon which this empirical study is based.

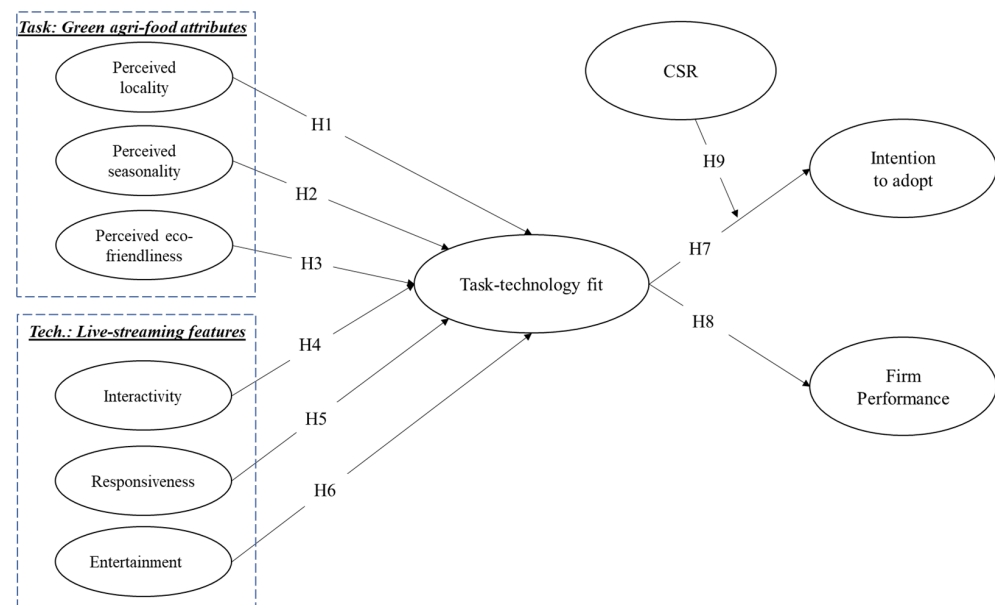


Figure 1. Conceptual model.

2.2. Task Characteristics of Green Agri-Food

According to TTF theory, the task refers to the action taken by individuals to transform input into output [22]. As general agricultural products, green agri-food have the local and seasonal characteristics. The plantation and marketing of green agri-food are cyclical and seasonal [30]. The marketing pressure of agricultural products is high during the harvest season, while it is relatively small during the nonharvest season. In addition, consumers are more likely to buy seasonal agricultural products because they believe that the seasonal agricultural products are more nutritious and safer [31–34]. Therefore, in the marketing of green agri-food, it is important to overcome the seasonal limitations to achieve production and sales. Moreover, green agri-food has obvious local characteristics, and they can only be grown in places that fulfill their soil and climatic conditions. Research shows that people think that agricultural products with local characteristics are fresher and healthier [31,35]. We made it our top priority to overcome the seasonal and local limitations of green agri-food in marketing.

Furthermore, in the marketing of agricultural products, green agri-food are organic, environment-friendly, and pollution free. In the production of green agri-food, environmental protection and quality of agricultural products are emphasized, pure naturalness is stressed, and artificially added chemical ingredients such as pesticides, fertilizers, and herbicides are prohibited. Eco-friendliness has a positive effect on consumer preference [2,31,32,36,37]. Consumers generally believe that green agri-food are environmentally friendly, healthy, and safe [37,38]. On the other hand, in the process of marketing, eco-friendliness of green agri-food cannot be directly conveyed to consumers. Due to the asymmetry of agricultural product information between sellers and buyers, a lack of trust toward green agri-food exists [39]. To demonstrate the eco-friendliness of green agri-food and the eliminate consumers' doubts effectively, it is urgent to introduce new technologies

to fit the marketing of green agricultural products. Therefore, the eco-friendliness of green agri-food is likely to become another task of this study.

Traditional e-commerce platforms cannot fully reflect the seasonal, local, and eco-friendliness characteristics of green agri-food. No timely, true, and effective marketing channel can reflect the characteristics of green agri-food in the process of marketing. The livestreaming technology directly connects consumers and products, restores the product information to the greatest extent, and provides users with a sense of reality: that is, what you see is what you get [7,8,16]. We expect that in the marketing of green agri-food, the seasonal, local, and eco-friendliness characteristics of green agri-food advance the fit of marketing and livestreaming. Thus, this study proposes the following hypotheses:

Hypothesis 1. *The locality of green agri-food has a positive effect on the fit of livestreaming of green agri-food.*

Hypothesis 2. *The seasonality of green agri-food has a positive effect on the fit of livestreaming of green agri-food.*

Hypothesis 3. *The eco-friendliness of green agri-food has a positive effect on the fit of livestreaming of green agri-food.*

2.3. Technology Characteristics of Livestreaming

According to TTF theory, technology refers to the tools used by individuals when they perform tasks. In terms of information system, technology includes computer systems and other supporting services that help users in complete tasks [22]. In the study, technology refers to livestreaming e-commerce technology. The livestreaming e-commerce technology combines the network platform and the livestreaming technology, providing a type of service whose data can be distributed simultaneously when the data are created [40]. The livestreaming e-commerce technology features interactivity, responsiveness, and entertainment [17,41].

Interactivity is a kind of communication technology, that is, to what extent that it supports information exchange and communication among people [42]. Interactivity is an important feature of e-commerce, which can help consumers control information when they lack experience on products [43]. The interactivity of livestreaming e-commerce includes not only the interaction between sellers and buyers but also the interaction among buyers or online shoppers [44,45]. Sellers answer the buyers' questions through livestreaming and displays the products according to the buyers' requirements. Online shoppers can also share shopping experiences for feedback and deliver more shopping information, which would help reduce the consumers' uncertainty in purchasing products and help potential consumers make better decisions [45,46].

The second characteristic of livestreaming e-commerce is responsiveness, which is combined with real-time interaction and e-commerce. Responsiveness is how the livestreaming e-commerce companies respond to the users' request, that is, how fast the seller and the user receive a quick response from the other party in the livestream [17,47,48]. The seller can control the product information and the users' consultation information in the livestream room in real time and make corresponding responses. Timely responses not only include the response to product details, on-site trials, and so on, but also real-time responses to streamer's facial expression, eye, and body language. This responsiveness conveys a wealth of information, which effectively reduces the consumers' shopping risks, increases the consumers' perception of the usefulness of commodities, and narrows the psychological distance between consumers and businesses [17,49].

Entertainment is also a major feature of livestreaming e-commerce [17]. Livestreaming e-commerce provides traditional e-commerce services, and the real-time and rich interactive function makes marketing itself more fun and helps buyers and sellers conclude transactions with pleasure. Sellers display agricultural products in a relaxed and pleas-

ant way, such as planting field, agricultural product picking, and processing. On the other hand, interesting interactive elements, such as grabbing red envelopes, barrage chat, bullet screen, and giving virtual gifts would enhance the usefulness of live e-commerce, shorten the psychological distance between sellers and buyers, and provide immersive and pleasurable shopping experience for users [17].

In the marketing process, to display the seasonal, local, and eco-friendliness of green agri-food, as well as reduce the uncertainty and risk in the consumption of green agri-food, a timely, credible, and verifiable marketing is needed. Moreover, Tajvidi et al. [50] and Lin et al. [51] have suggested that social commerce provides a good communication channel for the establishment of relationships between businesses and users. Active information sharing between users and merchants can enhance trust in social commerce, which in turn increases the level of satisfaction toward social commerce. Perceiving the characteristics and role of live e-commerce can improve the sense of fit in livestreaming marketing of green agri-food products. Therefore, this study predicts that the interactivity, responsiveness, and entertainment of livestreaming can fit the marketing task of green agri-food. The interactivity, responsiveness, and entertainment of livestreaming e-commerce have a positive effect on the fit of livestreaming e-commerce of green agri-food. Thus, this study proposes the following hypotheses:

Hypothesis 4. *The interactivity of livestreaming technology has a positive effect on the fit of livestreaming of green agri-food.*

Hypothesis 5. *The responsiveness of livestreaming technology has a positive effect on the fit of livestreaming of green agri-food.*

Hypothesis 6. *The entertainment of livestreaming technology has a positive effect on the fit of livestreaming of green agri-food.*

2.4. Task–Technology Fit, Technology Adoption, and Performance

TTF refers to what extent that technology helps individuals in performing their tasks. In view of TTF theory, TTF can not only increase the users' intention to adopt technology but also improve task performance [22]. The findings have been verified in many fields. In the field of social media and emergency management, the mobility of social media is fit for individuals who are seeking and sharing information and communicating with others in emergency situations. The TTF positively affects the intention to adopt mobile social media and improves the efficiency of completing tasks [52]. Shoppers perceive that technologies such as robotic shopping assistants, parcel storage cabinets, and drone deliveries can fulfill the shoppers' need for noncontact shopping, wherein the stronger the sense of fit is, the higher the willingness of adopting these technologies would be [25]. In the application of cloud mobile retail, sellers perceive that cloud mobile retail technology can help them manage orders in various regions. The stronger the fit between cloud mobile retail technology and order management task is, the greater the willingness of sellers to adopt cloud mobile retail technology and the higher the efficiency of order task completion would be [53]. In the research of IoT technology and disaster rescue management, scholars have confirmed that the information collection, transmission, and processing technology can help them analyze and understand the disaster scenes in the formulation of rescue plans. The fit of rescue missions and IoT technology can increase the adoption of IoT technology and improve the performance of rescue missions [24]. In the field of livestreaming, livestreaming technology promotes interaction between users, creates a pleasant marketing environment for sellers and shoppers, and increases the sales of experiential products [54].

In view of this, we speculated that the fit of green agri-food and livestreaming positively affects the intention to adopt livestreaming and firm performance. The greener agri-food companies perceive that the fit between green agri-food marketing and livestreaming

e-commerce technology, the stronger the willingness to adopt the livestreaming technology is, and the higher the firm performance would be. Thus, the study puts forward the following hypothesis:

Hypothesis 7. *The fit of livestreaming of green agri-food has a positive effect on the intention to adopt livestreaming e-commerce.*

Hypothesis 8. *The fit of livestreaming of green agri-food has a positive effect on the firm performance of green agri-food enterprise.*

2.5. Corporate Social Responsibility

Carroll (1979, 1991) used a four-frame pyramid to describe the components of CSR, which were economic, legal, moral, and charitable responsibilities. Among them, economic responsibility is at the bottom, which accounted for the largest proportion, followed by legal responsibility, moral responsibility, and charity responsibility. In the process of assessing CSR, Carroll determined that the social problem approach can be used to strengthen the relationship between corporate and society, reflecting the importance of social issues [55,56].

In recent years, social problems such as environmental deterioration and the wealth gap have been prominent, and the proportion of social and environmental responsibility in CSR has gradually increased. The European Commission stated in the Green Paper on Corporate Responsibility that companies should incorporate social and environmental responsibilities into their own business operations and interactions with relevant stakeholders, emphasizing that companies must perform their social and environmental responsibilities. E-commerce companies possess advanced technologies and a large amount of consumer data, and the fulfillment of social responsibilities by e-commerce companies can not only increase the users' trust and loyalty to the companies but also enhance corporate image [57,58].

Consumers evaluate CSR, and the results of the evaluation directly affect the consumers' willingness to consume [59–61]. When users perceive a strong sense of CSR, once the technology provided by a company fulfills the needs of consumers, the consumers' willingness to adopt the technology becomes stronger. Thus, when green agri-food firms perceive that e-commerce companies have a strong sense of CSR, they are willing to adopt e-commerce technologies as long as the livestreaming technologies provided by e-commerce companies would advance the marketing tasks of green agri-food. By contrast, when the sense of CSR is weak, the livestreaming technology is evaluated in time to support the marketing tasks of green agri-food, and the intention to adopt it is weak. The perception of CSR plays a moderating role between the fit of livestreaming of agri-food and the intention to adopt livestreaming. Therefore, the study proposes the following hypotheses:

Hypothesis 9. *The perception of CSR of livestreaming e-commerce moderates the relationship between the fit of livestreaming of green agri-food and the intention to adopt livestreaming e-commerce.*

3. Methodology

3.1. Sampling and Data Collection

We test our hypotheses on a sample of entrepreneurial firms from the Chinese agricultural industry. China provides an ideal research setting to empirically explore what motivates rural entrepreneurial firms in the agricultural industry to employ livestreaming on certain online platforms to sell their agricultural products and how these firms can achieve better performance outcomes by successfully creating a task–technology fit and engaging in CSR for the following reasons. With the successful digital transformation and development of digital economy, China has rapidly emerged as both the world's largest e-commerce market and biggest retail e-commerce market over the last decade. The country

now accounts for more than half of the worldwide online retail sales. According to the E-Commerce in China 2019 report released by China's Ministry of Commerce (MOFCOM), the e-commerce industry in China has achieved above-average growth over the past few years, and the total transaction volume of e-commerce in China reached approximately 35 trillion yuan (approximately USD 5 trillion using the official exchange rate) by the end of 2019. The online retail sales reached more than 10 trillion yuan (approximately USD 1.5 trillion). According to the 45th Statistical Report on the Development of China's Internet released by China Internet Information Center (CNNIC), there were more than 700 million online shoppers in China in 2019, and more than 37% of the online shoppers (2.65 million consumers) experienced shopping through e-commerce livestreaming. As reported by iiMedia Research, a market consultancy, the livestreaming e-commerce market in China achieved an annual growth of more than 121% reaching 961 billion yuan (approximately USD 138 billion) in 2020. Despite the rapid emergence and development of the livestreaming e-commerce industry in leading the recent e-commerce sales and its powerful effect on the whole digital economy of China, it has barely touched the agricultural industry, which may be one of the least innovative sectors in China. Amid slowing economic activity, COVID-19 has accelerated the growth of China's emerging livestreaming e-commerce in the agricultural industry, offering new growth opportunities for a wide range of farming business operators. Livestreaming has become a popular means for rural entrepreneurial firms. Smaller business operators in the agricultural industry can have better access to consumers to promote and boost the sales of their agricultural products. For example, there were more than 50,000 rural livestreamers on Taobao live by the end of first quarter of 2020. This number is roughly 49 times bigger than that in 2019 (1000). One million livestreaming sessions were held on Taobao Live, the livestreaming unit of the largest e-commerce platform in China operated by the Chinese e-commerce giant, Alibaba Group, during the third Chinese Farmer's Harvest Festival between September 22 and 24 in 2020. The livestreaming technology is rapidly creating a direct farm-to-kitchen business model for rural entrepreneurial firms operating farming business in the Chinese agricultural industry.

To collect data from rural entrepreneurial firms in the agricultural industry, we employed a survey in two regions of China: Zhejiang and Jiangsu. These two regions have seen explosive growth of the livestreaming e-commerce market. More importantly, they represent the most important and popular areas of the country for livestreaming e-commerce in the agricultural industry. To develop the questionnaire for the study, we followed a careful process by first developing an English version of the questionnaire and then translating it into Chinese with the help of two independent bilingual translators. To ensure conceptual equivalence and accuracy, the Chinese version of the questionnaire was back-translated into English by two additional independent translators who are competent in Chinese and English [62]. To ensure the content and validity of the measures to understanding the latest focal livestreaming phenomenon, we conducted five online in-depth interviews with five managers of firms actively engaging in livestreaming platforms to promote and sell their agricultural products. We then pilot-tested our survey instruments with 20 rural entrepreneurial farming business operators in the agricultural industry. Based on the feedback from the interviews and pilot tests, we further modified a few questionnaire items to ensure their relevance and clarity of the questionnaire items. Prior research has demonstrated the potential challenges faced in collecting sufficient primary firm data in China and argued for the importance of using *guanxi* (i.e., developing good relationship and trust) to increase high-quality responses [63]. Following the recommendation to encourage survey participation and enhance high-quality response rate, we administered the survey with the help of a renewed research company in the Chinese local market. Finally, we collected a total of 602 questionnaires. After excluding 28 irrelevant or incomplete responses, we received a total of 574 completed and usable questionnaires that are utilized for the final data analysis. Of the 574 agri-food entrepreneurial firms, most (80.7%) had less than 100 employees, and 78.6% had annual sales revenues of less than 1.5 million RMB. On

average, the respondents had been working for 9.6 years in the industry and 4.8 years with their firm.

3.2. Bias Testing

To verify the presence of nonresponse bias in the data that may possibly influence our statistical results, we compared the differences between the responding and nonresponding firms as well as the firms that responded to our survey early against those that responded late on key firm characteristics (e.g., firm sales, number of employees, and age). To check for this potential threat to validity, we considered the early-responding firms as the proxy for responding firms and the late-responding firms as the proxy for nonresponding firms under the assumption that the firms responded late are more similar to nonresponding firms than those responded early to those nonresponding ones [64]. Our results of a test show that there was no statistically significant difference between the firms that responded to our survey early and those that responded late on firm sales, number of employees, and firm age, suggesting no evidence of a serious concern on response bias in our data [64]. In addition, it has been suggested that the analysis of self-report survey data may suffer from potential common method variance (CMV). However, we do not believe that CMV is a significant problem in our study for several reasons. First, to mitigate a simple 'straight line' pattern of response, we separated the measures of our constructs into several subsections and used different formats when designing our questionnaire [65,66]. Second, to reduce the potential presence of CMV-biased response patterns, we randomized the order of the questions on the questionnaire using survey software and reversed the scaling on several questions. More importantly, all respondents were promised a strict anonymity and confidentiality of their responses in the survey cover letter. In particular, they were assured that the survey was only for the sake of academic research and that there were no right or wrong answers to the questions and they should simply respond to each question as honestly as possible. Nevertheless, we performed Harman's one-factor analysis, as recommended by Podsakoff, MacKenzie, Lee, and Podsakoff (2003), to assess the potential CMV concern in our data [67]. In doing so, we performed exploratory factor analysis by entering the variables in the study into a nonrotated factor analysis, and the results of the one-factor analysis indicate that no general factor is apparent in the unrotated factor structure and accounted for a majority of the variance. These results suggest that CMV should not be a significant concern in our data.

3.3. Variables and Measurement

Unless noted otherwise, all the dependent, independent, and moderating variables in the study were assessed using multiple-item, seven-point Likert scales ranging from "strongly disagree" (1) to "strongly agree" (7).

To develop the measure of the perceived eco-friendliness feature of agricultural products, we used four items derived from prior theoretical work [68–70], which focuses on the importance of environmentally friendly feature of products or services for customers. The perceived seasonality feature of agricultural products was evaluated using four items. Rural e-commerce entrepreneurial farmers were asked about the extent to which they believe that their agricultural products are strongly seasonal in price, cost, production, and supply. The perceived locality feature of agricultural products was assessed using three items. Respondents were asked about the extent to which they believe their agricultural products are locality-based ones. Previous studies have not used a multiple measurement approach to capture the seasonality and locality. Therefore, two subscales were designed to measure the two attributes of agricultural products. In line with the accepted definitions of seasonality and locality, we developed these two measures using prior theoretical work on seasonality [71–74] and locality [75–77]. Before including the scale of agricultural product attributed in the present study, the scale and respective items were administered to an independent sample of rural entrepreneurial farmers who are utilizing livestreaming to promote their agricultural products. The exploratory and confirmatory factor analyses

on data from the 190 questionnaires collected supported the agricultural product scale's three-factor structure. All items were loaded significantly ($p < 0.001$) on their expected factors, and the model's overall fit was satisfactory ($\chi^2 = 74.96$, $df = 41$, $CFI = 0.988$, $TLI = 0.984$, $NFI = 0.973$, $RMSEA = 0.06$).

Following Xue, Liang, Xie, and Wang [17], we measured responsiveness with four items. These items assess the degree to which a livestreaming platform meets rural e-commerce entrepreneurial farmers in anticipating and responding promptly and effectively to consumers [48]. On the basis of the works of Xue, Liang, Xie, and Wang [17] and Zhao, Wang, and Zhou [78], we captured the degree of interactivity using five items. These items assess the extent to which the rural e-commerce entrepreneurial farmers can provide consumers with help, advice, or information through a livestreaming platform. Entertainment refers to the extent to which the rural e-commerce entrepreneurial farmers can make consumers feel fun or pleasure through a livestreaming using the platform. Following prior work, we developed five items to capture the degree of perceived entertainment [17,79,80]. TTF captures the extent to which a livestreaming platform can match the rural e-commerce entrepreneurial farmers' needs and assist them in reaching consumers and endorsing their agricultural products through livestreaming [22]. To measure TTF, we adopted nine items from Howard and Rose [81] and Lam, Cho, and Qu [82]. We asked respondents to indicate the extent to which they can use livestreaming services in the platform to successfully reach consumers and market their agricultural products. To measure the differences in the engagement in CSR, we adopted 10 items from Luo [83] and Isabelle [84] and modified them specifically for this study. We asked the respondents to indicate the extent to which the firm is committed to engaging in CSR activities. To measure rural e-commerce entrepreneurial farmers' intention to adopt livestreaming in the platform, we used eight items developed by prior research and modified them to achieve the research objective [79,85,86]. These items capture rural e-commerce entrepreneurial farmers' continuous behavioral intention to use livestreaming, specifically gauging the extent to which they would like to take livestreaming in the platform in the future. To measure firm performance, we used five self-reported performance indicators that were adopted and modified from prior studies [87–90]. We asked rural e-commerce entrepreneurial farmers to assess their profitability, net profit margin, profitability growth, sales performance, and overall firm performance compared with those of their industry rivals.

4. Analyses and Results

To test our hypotheses empirically, we used partial least squares (PLS) structural equation modeling (SEM) [91]. SEM is a popular statistical approach that can be used to estimate a series of separate multiple regression equations simultaneously by integrating the logic of confirmative factor analysis and multiple regression. Due to the use of SEM as a unique and powerful utility to establish measurement and structural models simultaneously, we believe a SEM approach obviously offers vast potential to analyze key links in the study. Before empirically testing the hypotheses, we first assessed the reliability and validity of the constructs by checking the measurement model.

4.1. Measurement Reliability and Validity

Table 1 presents the results of the measurement assessment, which summarizes the means, standard deviations, factor loadings, construct reliabilities, and the average variances extracted (AVEs). Given that all the established scales were used to measure the variables in this study, all measures exhibit strong reliability and validity. As shown in Table 1, all the Cronbach's alpha values, ranging from 0.845 to 0.957, and composite reliabilities, ranging from 0.907 to 0.963, are greater than 0.80, exceeding the 0.70 benchmark [92,93]. Therefore, our constructs exhibit strong internal reliability. In addition, outer loadings of all constructs are statistically significant with values greater than 0.80, indicating that the measurement model is strongly reliable [94,95]. We also calculated the AVE values for the constructs, and the results showed that all values are above the 0.50 cutoff, ranging

from 0.716 to 0.806. These results suggest that the measures exhibited adequate convergent validity and reliability [92]. Following the convergent validity analysis, we assessed the discriminant validity by comparing the square root of AVE of each construct and correlation between the construct and other constructs in the model. As shown in Table 2, the results verified that the square root of AVE of each construct is higher than the correlation between the construct and others, providing an adequate discriminant validity of the measures [92]. To verify the discriminant validity of the measures, we also compared the loading values of each single indicator with the crossloadings with other indicators. The results show that each indicator loading is higher than the respective crossloadings, again suggesting adequate discriminant validity of the measures. Moreover, we checked the heterotrait–monotrait ratio (HTMT) of the correlations [96], and the results indicated that all HTMT correlations values are not greater than 0.85, suggesting satisfactory discriminant validity for all constructs in the model. Lastly, following prior work [97,98], we used Stone–Geisser’s Q^2 to assess the predictive validity of the latent constructs in the model. The results showed that the crossvalidated communality and redundancy values are higher than zero, ranging from 0.282 to 0.497, demonstrating adequate predictive validity in the model [94,99]. Overall, the constructs and their respective indicators exhibit strong reliability and validity in the context of this study.

Table 1. Descriptive statistics and validity assessments of the constructs.

Construct and Indicators	Mean	STD	Item Loading	Cronbach’s Alpha	CR	AVE
Perceived locality (LOC)				0.845	0.907	0.764
LOC1	5.223	1.250	0.834			
LOC2	5.267	1.250	0.884			
LOC3	5.326	1.281	0.904			
Perceived seasonality (SEA)				0.904	0.933	0.776
SEA1	5.321	1.286	0.866			
SEA2	5.347	1.304	0.874			
SEA3	5.300	1.284	0.901			
SEA4	5.282	1.348	0.883			
Perceived eco-friendliness (ECF)				0.920	0.943	0.806
ECF1	5.376	1.354	0.901			
ECF2	5.340	1.314	0.896			
ECF3	5.303	1.398	0.898			
ECF4	5.305	1.333	0.896			
Responsiveness (REV)				0.907	0.935	0.782
REV1	5.211	1.271	0.873			
REV2	5.213	1.223	0.883			
REV3	5.129	1.240	0.896			
REV4	5.275	1.280	0.885			
Interactivity (INT)				0.923	0.942	0.764
INT1	5.084	1.418	0.871			
INT2	5.148	1.287	0.872			
INT3	5.174	1.292	0.872			
INT4	5.286	1.264	0.880			
INT5	5.235	1.276	0.874			
Entertainment (ENT)				0.917	0.938	0.750
ENT1	5.152	1.256	0.899			
ENT2	5.131	1.287	0.880			
ENT3	5.005	1.295	0.868			
ENT4	5.172	1.326	0.868			
ENT5	5.000	1.254	0.814			

Table 1. Cont.

Construct and Indicators	Mean	STD	Item Loading	Cronbach's Alpha	CR	AVE
Task–technology fit (TTF)				0.954	0.961	0.730
TTF1	5.265	1.300	0.852			
TTF2	5.230	1.294	0.843			
TTF3	5.172	1.271	0.869			
TTF4	5.172	1.286	0.852			
TTF5	5.282	1.255	0.852			
TTF6	5.157	1.312	0.865			
TTF7	5.193	1.243	0.845			
TTF8	5.186	1.286	0.859			
TTF9	5.268	1.292	0.854			
Corporate social responsibility (CSR)				0.957	0.963	0.722
CSR1	5.305	1.321	0.850			
CSR2	5.416	1.300	0.852			
CSR3	5.394	1.299	0.846			
CSR4	5.240	1.276	0.853			
CSR5	5.343	1.317	0.844			
CSR6	5.293	1.286	0.855			
CSR7	5.303	1.287	0.849			
CSR8	5.368	1.298	0.851			
CSR9	5.366	1.327	0.848			
CSR10	5.420	1.363	0.852			
Intention to adopt (ITA)				0.943	0.953	0.716
ITA1	5.009	1.781	0.818			
ITA2	5.131	1.606	0.838			
ITA3	4.716	1.606	0.864			
ITA4	4.247	1.870	0.847			
ITA5	4.301	1.570	0.853			
ITA6	4.429	1.580	0.841			
ITA7	4.699	1.583	0.849			
ITA8	4.770	1.595	0.859			
Firm performance (PER)				0.922	0.941	0.762
PER1	5.401	1.428	0.884			
PER2	5.375	1.392	0.890			
PER3	5.125	1.402	0.860			
PER4	5.122	1.404	0.878			
PER5	5.136	1.331	0.852			

Note: AVE = average variance extracted, CR = composite reliability, and STD = standard deviation. Due to space limitations, detailed measurement items are omitted, but they are available from the corresponding author upon request.

Table 2. Correlations and discriminant validity among the constructs.

Variables	1	2	3	4	5	6	7	8	9	10
1. Perceived eco-friendliness	0.898									
2. Perceived seasonality	0.582	0.881								
3. Perceived locality	0.567	0.558	0.874							
4. Responsiveness	0.522	0.514	0.483	0.884						
5. Interactivity	0.480	0.399	0.434	0.669	0.874					
6. Entertainment	0.562	0.547	0.478	0.671	0.676	0.866				
7. Task–technology fit	0.623	0.568	0.584	0.713	0.696	0.739	0.855			
8. Corporate social responsibility	0.651	0.610	0.630	0.705	0.695	0.700	0.790	0.850		
9. Intention to adopt	0.420	0.408	0.381	0.532	0.600	0.618	0.616	0.599	0.846	
10. Firm performance	0.583	0.505	0.519	0.656	0.685	0.687	0.714	0.730	0.665	0.873

Note: Values in italicized bold denote the square root of the AVE of each construct.

4.2. Hypothesis Testing

Following the measurement model estimation, we empirically tested the theoretical model and the hypotheses. Figure 2 presents the results of the structural equation modeling analysis. Following Chin's (1998) approach [94], we estimated the coefficient of determination R^2 and the path coefficient with their respective t-values. The R^2 values for the three endogenous variables (e.g., task–technology fit, intention to adopt livestreaming services, and firm performance) indicate satisfactory explanatory power for our model (0.422–0.708). Overall, the results presented in Figure 2 indicate that the constructs are largely related in the theoretically predicted manner. Specifically, the results show a significant positive relationship between the two features of agricultural products, that is, perceived locality ($b = 0.144$, $t = 3.475$, $p < 0.01$), perceived eco-friendliness ($b = 0.137$, $t = 2.640$, $p < 0.01$), and TTF for rural e-commerce entrepreneurial farmers who are using livestreaming to reach consumers and to sell their agricultural products, such as fruits and vegetables, in China. We also find corroborating evidence of a positive and significant relationship between three features of livestreaming services, that is, interactivity ($b = 0.220$, $t = 4.327$, $p < 0.001$), responsiveness ($b = 0.213$, $t = 4.484$, $p < 0.001$), entertainment ($b = 0.266$, $t = 4.632$, $p < 0.001$), and task–technology fit for rural e-commerce entrepreneurial farmers who are using livestreaming. Therefore, these results indicate that the perceived locality and eco-friendliness features of agricultural products, and the features of livestreaming services (i.e., interactivity, responsiveness, and entertainment), as hypothesized, are key determinants of the technology appropriateness for rural e-commerce entrepreneurial farmers to reach consumers and market their agricultural products through livestreaming. These results support Hypotheses 1, 3, 4, 5, and 6. However, the perceived seasonality of agricultural products does not have a significant effect on the task–technology fit ($b = 0.065$, $t = 1.652$); hence, Hypothesis 2 is rejected.

Furthermore, we examined the contribution of the technology appropriateness for online livestreaming to rural entrepreneurial farmers' intention to adopt livestreaming as an approach to reach consumers and market their agricultural products as well as the perceived benefits and usefulness of achieving the TTF in improving their performance. As shown in Figure 2, the path coefficients from TTF to both rural entrepreneurial farmers' intention to adopt livestreaming ($b = 0.616$, $t = 16.895$, $p < 0.001$) and their performance improvement ($b = 0.714$, $t = 21.811$, $p < 0.001$) are highly significant and in the predicted positive direction. Therefore, Hypotheses 7 and 8 are supported. These results imply that achieving a successful TTF can motivate rural entrepreneurial farmers to adopt livestreaming and help them achieve better performance by using a livestreaming service.

Finally, we tested Hypothesis 9 by examining the possible role of engagement in CSR in moderating the relationship between the TTF and rural entrepreneurial farmers' intention to adopt livestreaming. As shown in Figure 2, the path coefficient of the interaction term between the TTF and engagement in CSR is positive and statistically significant ($b = 0.045$, $t = 2.985$, $p < 0.01$). This result indicates that engagement in CSR plays an important role in positively moderating the effect of TTF on rural entrepreneurial farmers' intention to adopt their livestreaming services. More importantly, when the moderator (i.e., CSR engagement) is concluded in the model, the R^2 of rural farmers' intention to adopt livestreaming services is further increased from 0.379 to 0.422. On the basis of these results, Hypothesis 9 is supported. These findings suggest that engagement in CSR greatly helps enhance rural entrepreneurial farmers' intention to adopt livestreaming services by achieving technology appropriateness for marketing their agricultural products in the platforms. In the following section, we discuss these results and their implications.

To check the robustness of the SEM results, we performed regression analyses and SEM analyses by using Amos approach to verify the hypothetical relationships of the study. The results of the regression analyses and the SEM analyses using Amos are effectively equivalent to our results achieved from the use of the PLS SEM estimation, providing strong support for our main results. Owing to space limitations, we report only the results

of the PLS SEM estimation here. The results of the robustness check of our regression and Amos-based SEM are available upon request.

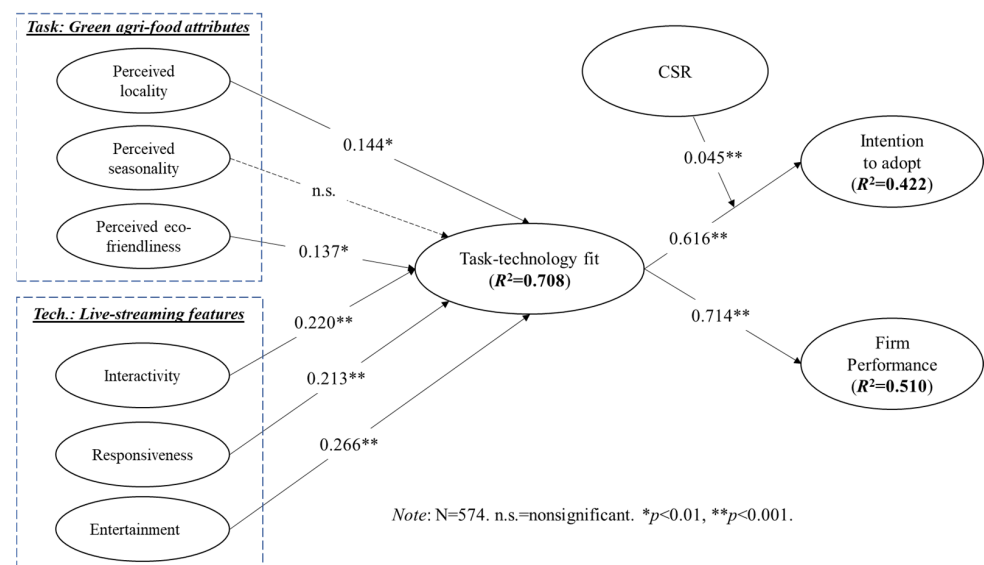


Figure 2. Estimated results of the hypothesis tests using a structural equation modeling.

5. Discussion and Conclusions

The main purpose of this study is to examine whether livestreaming e-commerce technology can help green agri-food firms achieve production and marketing connection. Our results reveal that a good fit exists between livestreaming e-commerce and green agri-food marketing. The introduction of livestreaming into green agri-food marketing can effectively demonstrate the locality and eco-friendliness of green agri-food and bring obvious performance to green agri-food enterprises.

The findings are consistent with the fact that livestreaming can improve marketing performance [13,41,44]. When agricultural product marketing is eco-friendly and local, the responsiveness, interactivity, and the entertainment of livestreaming e-commerce technology fit the marketing well. This helps agricultural firms and consumers achieve information symmetry. The responsiveness and interactivity of livestreaming would make the eco-friendliness information and local information of agricultural products be transmitted in time between the supply and demand sides, which promotes the effective flow of agricultural product information between sellers and buyers and solves the problem of asymmetry of product information.

Furthermore, the responsiveness and interactivity of livestreaming are conducive to two-way real-time communication between buyers and sellers. Green agri-food enterprises can make timely adjustments and feedback according to consumer needs and let users buy safe and satisfactory green agri-food. The real-time online interaction of livestreaming of green agri-food enriches product information allows users to understand the agricultural products they purchase in a comprehensive and true manner and improves the users' trustworthiness in agricultural products [100]. The real-time communication and interactive marketing provided by livestreaming e-commerce has broken the limitation of traditional agricultural product marketing that mainly conveys product information through pictures and text, making agricultural product marketing more fun [41]. The livestreaming technology is not only helpful to the marketing of green agri-food but also has a positive effect on firm performance and e-commerce adoption willingness. When agricultural product firms perceive the fit of agricultural product sales and live e-commerce technology, agricultural product firms are more willing to adopt livestreaming e-commerce. Thus, agricultural product sales performance is also improved.

Unfortunately, the seasonality of green agri-food has no significant effect on the fit of livestreaming of green agri-food. The seasonal problem requires the participation of multiple parties, which must be resolved by accelerating the construction of the supply chain system, goods collection warehousing, and cold chain transportation. It is a problem that cannot be solved by a single technology independently [101,102]. Although green agri-food firms recognized that livestreaming provides effective production and marketing connection, truly helps green agri-food firms, and effectively displays the characteristics of agricultural products, users can intuitively feel the locality and eco-friendliness of green agri-food. However, the seasonality is still a knotty problem. Green agri-food firms believe that livestreaming technology cannot solve the marketing problems caused by seasonality.

Findings also show that the green agri-food enterprises' perception of CSR toward livestreaming enterprises has a moderating effect on the relationship between the fit of livestreaming of green agri-food and livestreaming e-commerce adopt intention. That is, in the presence of high CSR, the stronger the green agri-food livestreaming fit, the more the intention to adopt livestreaming is. By contrast, in the presence of low CSR, the weaker the green agri-food livestreaming fit, the lower the intention to adopt livestreaming. The result is consistent with previous studies on consumer CSR attribution [60,61]. When green agri-food enterprises perceive that e-commerce companies have a high sense of CSR, they realize more that the livestreaming platforms provided by e-commerce companies are compatible, and they more actively adopt livestreaming platforms to repay e-commerce companies. This reflects that the fulfillment of CSR triggers a virtuous circle.

For theoretical implications, this study fills the relatively blank field of enterprise user behavior research. Our study explores the fit between livestreaming e-commerce and green agri-food marketing and reveals the applicability of livestreaming technology in the field of agricultural product marketing. This study verifies that livestreaming is helpful to the production and marketing connection. It proves that livestreaming technology can help green agri-food enterprises complete marketing tasks and confirms that green agri-food livestreaming fit has a positive role in the willingness of livestreaming adoption and performance. It provides a theoretical basis for the application of livestreaming technology in the agricultural field. Furthermore, this study adds CSR variables on the basis of the original TTF theoretical framework. In addition, research confirms the regulatory role of CSR in the development of livestreaming e-commerce, which not only verifies the results of TTF theory but also expands and broadens the scope of application of TTF theory, providing new ideas and bases for the subsequent research of the adoption of live e-commerce.

For managerial implications, the findings regarding the fit between livestreaming e-commerce and green agri-food indicate that livestreaming technology can be a good marketing channel and tool when green agricultural products have regional and eco-friendly characteristics. Therefore, green agricultural products can expand the sales channels and connect with end users by actively adopting live e-commerce services.

This study also suggests that when agricultural products are at risk of slow sales, green agri-food firms should rely on livestreaming technology to improve their production and marketing abilities within and outside their regions. E-commerce companies should also activate green channels for farmers and expand the marketing channel for unsellable agricultural products. At the same time, e-commerce should increase targeted assistance to green agri-food enterprises such as the provision of targeted training courses and services and provide preferable logistics services at lower costs in regions where sales of agricultural products are restricted.

Moreover, in order to pursue sustainable development, e-commerce companies should have corresponding ways to fulfill their CSR, such as supporting the development of weak industries, increasing the income of farmers, and exerting an effort in environmental protection. E-commerce companies should use their own advantages to carry out their corporate environmental responsibilities and social responsibilities, support weak industries, and enhance the development of agriculture on the supply side, which can not only establish a good corporate image but also have a positive effect on the long-term development

of e-commerce companies. When e-commerce companies conduct their CSR activities, donations, charity, and participation in public welfare are not enough. Business users expect that e-commerce companies can use their own technological resources to support weak industries, thus effectively solving social problems. Therefore, e-commerce companies should integrate CSR into the core business and business strategy, use their own advantages to coordinate the economic benefits and social responsibilities, and accelerate the healthy and sustainable development of e-commerce companies.

6. Limitations and Future Study

First, in terms of limitations, this study uses a questionnaire survey method to collect data. Affected by factors such as manpower, time, and economy, the respondents are individual green agri-food firms in China. The findings are not universal. On the other hand, the products are only green agri-food. In future studies, we will expand the scope of product application and the collection of overseas data to explore whether the model will have cross-regional and cross-cultural influences.

Second, the study mainly focuses on the inherent characteristics of green agri-food and the technical characteristics of livestreaming technology, while ignoring the organizational characteristics of agricultural enterprises, such as the organizational scale, organizational technological innovation, organizational culture, and other variables. In future studies, we will add organizational characteristic variables related to technology adoption to improve this study model.

Third, numerous short video platforms have also provided livestreaming e-commerce services, and each livestreaming e-commerce platform may have different technical characteristics. In this study model, this type of livestreaming e-commerce platform is not subdivided, wherein only the general characteristics of livestreaming e-commerce are considered. In future studies, we will subdivide the types of livestreaming e-commerce platforms and deepen the study of this model.

Fourth, while we focus on examining the effect of task–technology fit which is predicted by various green agri-food attributes and livestreaming features, future research might fruitfully examine how consumer reactions, such as consumer awareness and service satisfaction, and other mechanisms would shape entrepreneurial firms' intention or decision to adopt e-commerce and their firm performance.

Finally, this study focuses on the positive aspects of livestreaming e-commerce, and it does not mention the challenges such as the low conversion rate and insufficient exposure of sellers. In future studies, we will discuss the negative issues of livestreaming e-commerce and deepen the study on the livestreaming of green agri-food.

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Abbreviations

TTF Task–technology fit
CSR Corporate social responsibility

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