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WeChat E-Commerce, Social Connections, and Smallholder Agriculture Sales Performance: A Survey of Orange Farmers in Hubei Province, China

Di Liu [1,2] and Pan Wang [2,*]

[1]   College of Economics and Management, Hubei University of Education, Wuhan 430205, China; liudi@hue.edu.cn
[2]   Rural Sustainable Development Research Center, Huazhong Agricultural University, Wuhan 430070, China
*   Correspondence: wp97@webmail.hzau.edu.cn

Abstract: WeChat is a social media widely used in rural China because of its operability and simplicity. This paper contributes to the role of WeChat in rural e-commerce. Based on 406 orange farmers' survey data from Hubei Province, China, we used the Heckman model to analyze the factors that influence farmers' participation in WeChat e-commerce and estimate the impacts of WeChat e-commerce on farmers' sales performance. We found that information literacy and social connections are important factors affecting farmers' participation in WeChat e-commerce. WeChat e-commerce has a positive effect on farmers' sales performance, and the social connections between farmers and consumers can reinforce this effect. Particularly, the beneficial effects are more prominent for farmers with a higher level of Internet development, who operate on a smaller scale, and who are less educated. The results show that WeChat e-commerce improves sales performance mainly by increasing the quantity of sales and the profit rate. These findings will help countries like China to use daily social media to develop rural e-commerce.

Keywords: WeChat; e-commerce; social connections; sales performance; China

1. Introduction

The development of rural e-commerce plays a crucial role in increasing farmers' income and eradicating poverty, especially among the less economically developed regions of China [1]. In 2019, the Chinese government clearly pointed out the implementation of the "Internet + smallholder farmers" program to expand the coverage of rural e-commerce. The online retail sales of agricultural products in China reached 1.79 trillion CNY in 2020 [2]. Many scholars have suggested that formal large e-commerce platforms, such as Taobao and Jingdong, can help smallholder farmers connect to large markets [3–5]. Most of these studies argue that rural e-commerce can help farmers escape from their disadvantaged market position of being exploited and squeezed by many trading intermediaries [6].

However, some studies increasingly questioning the profitability of farmers on e-commerce platforms, especially for many smallholder farmers in China. Specifically, the lack of capital accumulation, skills, and information access among smallholder farmers has put them at a real disadvantage in terms of their rural e-commerce development [7]. Moreover, the rapid dynamic changes in Internet technology and economic markets have increased the risks and opportunity costs faced by farmers [6]. Farmers' e-commerce sales behaviors are blocked due to personal ability constraints and the complex information technology environment [8], and only a small percentage of large-scale farmers have the ability to benefit from e-commerce platforms [9]. The vast majority of rural farmers are not able to master the e-commerce platform's formal operation management. So, how does e-commerce work for these farmers who are at a disadvantage?

With the development of social networking on the Internet, WeChat has become a highly popular mobile social platform in rural China. Furthermore, the phenomenon of using WeChat's "circle of friends" to share and disseminate information about product supply in order to gain access to e-commerce channels to sell agricultural products is growing in China [10]. Compared to large formal e-commerce platforms, such as Taobao and Jingdong, WeChat e-commerce links producers and consumers in a more stable way through social relationships. WeChat also e-commerce uses communication, dissemination, sharing, interaction, and other information delivery forms to sell goods [11]. This has the advantage of low market entry barriers and easy-to-learn operational standards compared to online e-commerce platforms' system operations [12]. Relying on a high frequency of use, ease of operation, and strong social relationships, WeChat e-commerce has gradually become a new mode of e-commerce development in rural areas [13] and a good choice for an increasing number of smallholder farmers to participate in rural e-commerce.

Previous studies have focused on WeChat e-commerce as a new model of e-commerce, especially in terms of its novelty and functionality [12,14]. Because the emergence of WeChat e-commerce has been relatively recent, current research on it still remains at the conceptual level of connotations, characteristics, and models and therefore requires deeper empirical studies [12,13]. The answer to the question "Can social WeChat e-commerce effectively improve the sales performance of farmers?" is rarely discussed in depth by scholars. However, the answer to this question may provide new opportunities for farmers, especially smallholders, to access rural e-commerce. Based on the above analysis, this study uses the survey data of 406 orange farmers in 10 villages in Zigui County, Hubei Province, the famous "China Orange Town," to answer 3 questions: What are the factors that influence farmers' decisions of participation in WeChat e-commerce? What is the role of social connections in WeChat e-commerce, which has typical social media characteristics? What are the effects and mechanisms of the impact of WeChat e-commerce on farmers' sales performance? By answering the above three questions, the impact of WeChat e-commerce on farmers' sales performance can be verified, and the mechanism of WeChat e-commerce on farmers' sales performance improvement can be analyzed. In this way, we can guide farmers to make correct decisions on e-commerce participation and better utilize the positive effects of e-commerce on farmers' income increase.

The contributions of this paper are as follows: First, WeChat, as a social medium, has been developed as an important rural e-commerce channel in China. The development of WeChat e-commerce is of great significance to the sales of agricultural products in China, and its related research is also highly representative and specific. However, scholars have seldom empirically analyzed the role of WeChat e-commerce in the development of agricultural products channels. We conduct an empirical analysis with a sample of Chinese farmers to complement the gap between WeChat and rural e-commerce research. Second, based on social network theory, we introduce the important variable of social connections, which is argued to play an important role in WeChat e-commerce. This is a typical characteristic of WeChat e-commerce that distinguishes it from other e-commerce platforms. Third, we attempted to evaluate the beneficial effects of WeChat e-commerce on farmers' marketing performance. This will provide a useful reference for rural development of e-commerce based on social media. We hope that this study will provide practical policy guidance for resolving the dilemma of rural e-commerce development and seeking new paths for rural e-commerce development.

2. Literature and Hypothesis

2.1. Literature Review

WeChat e-commerce is a new e-commerce sales channel model with the help of WeChat version 8.0.42 social software as a tool, centered on people and linked by social networking. It mainly generates trust through social interaction between people and conducts transactions in the form of product information sharing. WeChat e-commerce is currently very popular in China because of its easy-to-use features [10]. WeChat e-

commerce is a combination of traditional methods with the Internet on an individual basis, which does not have regional restrictions and can be mobile in achieving new breakthroughs in sales channels [3]. It is also a mobile social e-commerce model that can quickly develop target markets with the help of WeChat and carry out various marketing activities to achieve sales goals [11]. According to social network theory, WeChat is mainly "acquaintance social", which is the continuation of real interpersonal relationships on the network [15]. WeChat e-commerce is a kind of acquaintance economy that relies on acquaintances to conduct transactions [16].

Furthermore, there are many factors that affect farmers' participation in e-commerce. First, there are personal factors, of which information literacy is considered important in the development of e-commerce. Although farmers are free and equal to compete in the e-commerce market [1], the online channels built by formal and large e-commerce platforms actually put up many invisible barriers for users [8]. For example, farmers must fully understand the communication processes and systems of e-commerce in order to operate the e-commerce management platform proficiently. The information literacy of smallholder farmers will directly affect the stability of e-commerce platform operations [6]. Second, there are social factors that affect farmer's participation in e-commerce, including government organizations and the e-commerce environment. Government organizations can encourage farmers to participate in e-commerce through policies and also provide training to improve their information literacy. Farhoomand et al. [17] argue that some problems encountered in the development of rural e-commerce can only be solved through the role of the government. Zeng et al. [18] argue that the government should provide farmers with some policy measures, such as credit taxation and professional skills training, to reasonably control the digital dividend gap. In addition, inadequate network information infrastructure can easily produce the "digital divide" phenomenon, which makes it more difficult for poor rural areas to access information [5].

The development of rural e-commerce has a positive impact on the marketing performance of agricultural products. For example, Tao et al. [19] pointed out that online sales of agricultural products can help optimize agricultural supply chain resources and reduce distribution links and sales costs based on a big data context. Iftikhar and Khan [20] also found that the online channel has higher operational efficiency than the offline channel because the former improves the efficiency of farm operations by enhancing purely technical efficiency. It is known from the market supply–demand equilibrium theory that a lack of information on product transactions leads to a loss of economic efficiency [21]. The trading of agricultural products involves multiple participants and circulation chains, such as producers, retailers, and consumers. There is a high probability of missing market information during traditional offline trading [22]. Internet technology can optimize the flow and sharing of information in agricultural product trading and increase the mastery of information by trading participants [5]. This is because online channels for agricultural products organically integrate and share information on agricultural production, distribution, markets, and trading chains, which can effectively reduce transaction costs and increase market transparency [23].

2.2. Hypothesis

There are three possible reasons for why WeChat e-commerce promotes farmers' agricultural product sales performance: (1) Transaction costs. WeChat e-commerce can reduce the cost of publicity by using relationships with a circle of friends and acquaintances to promote products. In addition, WeChat e-commerce can avoid intermediaries by directly connecting producers and consumers, thereby reducing transaction costs [5]. (2) Transaction price. WeChat e-commerce can improve sales prices by directly connecting producers and consumers. In addition, most agricultural products sold online need simple processing, classification, or packaging, which can further create product value [24]. (3) Transaction volume. WeChat e-commerce can promote the sales of agricultural products. Traditional offline sales can only target the local market, which can easily cause the dilemma of

oversupply. Online e-commerce can sell agricultural products to more non-local markets and expand the market's boundaries [13].

According to social network theory, WeChat e-commerce is essentially a social selling activity using interpersonal relationships [12]. Therefore, the social connections between farmers and consumers are an important guarantee for WeChat e-commerce to carry out sales activities [25]. Mcfadyen and Cannella [26] point out that social networks are relatively stable systems of social relationships between individuals who gradually build relationships with others in the course of their social activities. As individuals interact with each other more frequently, more information is exchanged between them. When a smallholder farmer has stronger social connections, he or she interacts with potential consumers more frequently and with more content. Such strong social connections will increase the trust between traders and lead to e-commerce transactions [16]. The stability of these social connections represents a win–win collaboration, often defined as an intimate interaction between trading partners, and the tendency to create value through collaboration [27]. Trada and Goyal [23] also point out that stable cooperative relationships among channel members are beneficial for reducing transaction costs and increasing product revenue. On the contrary, when farmers lack social connections, the transaction group and effect of WeChat e-commerce will be limited.

According to the above analysis, this paper proposes a research hypothesis: WeChat e-commerce participation positively affects farmers' agricultural sales performance, and this effect is moderated by the strength of social connections.

3. Methods and Materials

3.1. Data Collection

China is a major global producer of oranges. The cultivation of oranges in China is concentrated mainly in central and southern China, especially in and around Guangxi, Hubei, Hunan, and Jiangxi. Hubei Province is one of the main orange-production provinces in China, with a specific concentration in Zigui County, which has a unique geographical and climatic environment. Zigui County is well known as "China's Orange Town" and has a planting history going back more than 2000 years. In this county, more than 140,000 people grow navel oranges, with a planting scale of more than 20,000 hectares and an annual output of more than 400,000 tons. The most concentrated orange-production areas in Zigui County are the towns of Guojiaba, Guizhou, Shuitianba, and Shazhenxi. In July 2021, our research group randomly selected 2 of the 4 towns mentioned above, and then 10 villages were randomly selected from the 2 towns that had been selected, after which 30–50 farmers were randomly selected in each village to conduct one-on-one interviews and fill out questionnaires by the investigators. The investigators consisted of Ph.D. students and M.S. students from this research group. In addition, to ensure the accuracy of the data, special training was provided to the investigators before the research. The content of the research questionnaire focuses mainly on orange planting and marketing and includes the basic situation of villages, farmers' characteristics, farmers' information literacy, channel selection, marketing results, and farmers' perception of policies. We collected a total of 423 pieces of data during the research process, but due to the fact that some interviews were forcibly terminated or the interviewees were replaced during the survey process, 17 such questionnaires were excluded when considering the validity of the questionnaire data. Finally, we obtained a total of 406 valid questionnaires, with a sample validity rate of 96.0%.

3.2. Model

During the survey, it was found that farmers sell their oranges through various channels. Considering the heterogeneity of the degree of WeChat e-commerce participation, we chose to use the Heckman model to simultaneously estimate the influencing factors affecting the behavior and degree of farmers' participation in WeChat e-commerce. On the one hand, this model can avoid self-selection bias because farmers' participation behavior

in WeChat e-commerce is not random. On the other hand, the factors influencing the level of participation in WeChat e-commerce cannot be estimated by the binary Logit model [28]. The first stage estimates the factors influencing whether farmers participate in WeChat e-commerce:

$$\text{Logit}(Y_1) = \log(\frac{P}{1-P}) = \beta_0 + \sum_{i=1}^{I} \beta_i \chi_i + \varepsilon_1 \tag{1}$$

where P and Y_1 are the probability and decision that farmers whether to participate in WeChat e-commerce to sell oranges, respectively. χ_i are the other factors affecting farmers' decisions. β_i is the coefficient to be estimated. Then, the second-stage regression is the factors influencing the level of participation in WeChat e-commerce:

$$Y_2 = \beta_0 + \sum_{j=1}^{J} \beta_j \chi_j + \beta\lambda + \varepsilon_2 \tag{2}$$

where Y_2 indicates the level of farmers' participation in WeChat e-commerce—that is, the proportion of WeChat e-commerce sales of total sales. χ_j are the other influencing factors. β_j is the coefficient to be estimated. Considering the problem of selective bias of the sample, the inverse Mills ratio λ should be obtained by dividing the density function of the normal distribution and the cumulative distribution function. That is, $\lambda = \phi(\hat{\alpha}\chi_i)/\varphi(\hat{\alpha}\chi_i)$. Of course, in order to avoid the interference of other possible factors, we controlled as much as possible for other variables that might influence farmers' decisions, and the statistical significance of λ should be tested.

Secondly, we used OLS to estimate the impact of WeChat e-commerce participation on sales performance. The following model was constructed:

$$\text{SalesPer} = \alpha_0 + \alpha_1\text{WeChat} + \alpha_2\text{SocialCon} + \alpha_3\text{WeChat} \times \text{SocialCon} + \alpha_4\text{cons}_i + \mu_i \tag{3}$$

where SalesPer is the sales performance of farmers. SocialCon refers to the social connections between farmers and consumers, and WeChat refers to the behavior of farmers using WeChat e-commerce to sell products. The interaction term WeChat $\times$ SocialCon is used to test the impact of WeChat e-commerce on farmers' sales performance under different social connections scenarios. cons refers to the control variables of the model. α_0 is the intercept term. α_i are the coefficient to be estimated. μ_i is the random error obeying normal distribution.

3.3. Variable Selection

(1) Sales performance: Sales performance refers to the total revenue after a period of marketing operations. In this paper, sales performance refers to the total revenue of farmers from the sale of oranges in the year during which farmers were interviewed.

(2) WeChat e-commerce: WeChat e-commerce refers to a general term for users carrying out business activities through the WeChat platform [3,11]. In this paper, WeChat e-commerce refers to the behavior of farmers using WeChat social media to sell oranges on the Internet. For the estimation of Heckman's two-stage model, the dependent variable in the first stage regression is farmer deciding whether to participate in WeChat e-commerce. Define $Y_1 = 1$ means that farmer uses in WeChat to sell oranges, and $Y_1 = 0$ means that WeChat is not used. If the effect of the variable in the first stage on Y_1 is positive, it indicates that the variable can promote farmers' participation in WeChat e-commerce. Further, the dependent variable Y_2 in the second stage of regression estimation is set as the level of farmers' participation in WeChat e-commerce, which can be measured by the percentage of WeChat e-commerce sales. If the variable has a positive effect on Y_2 in this stage, it indicates that the variable can effectively improve the sales effect of WeChat e-commerce.

(3) Social connections: Social connections can generally be classified into strong and weak relationships based on four dimensions: frequency of interaction, strength of affection, degree of intimacy, and reciprocal exchange [29]. The difference is that the online social

connections accumulated based on the WeChat platform emphasize the interaction and trust between people [30]. So, we refer to Haas et al. [27] and Yang and Che [12] to measure the social connections in WeChat e-commerce mainly in three dimensions: intimacy, interaction frequency, and trust level. In the questionnaire, we used the items of the Likert 5 subscale to measure the indicators (Table 1).

Table 1. Descriptive statistical characteristics of the independent variables.

Category	Variables	Definition and Measures	AVE	S.D.
Dependent variable	Sales performance	Total revenue after a period of marketing operations (10,000 CNY)	6.744	6.712
Independent variable	WeChat e-commerce	The farmer participates in WeChat e-commerce: Yes = 1, no = 0	0.347	0.477
Moderator variable	Social connections	Intimacy: You are close to the consumer: 1 = strongly disagree=; 2 = rather disagree; 3 = generally; 4 = rather agree; 5 = strongly agree	3.729	0.558
		Interaction frequency: You have a high frequency of interaction with consumers: 1 = strongly disagree=; 2 = rather disagree; 3 = generally; 4 = rather agree; 5 = strongly agree	3.163	0.877
		Trust: There is mutual trust between you and the consumer: 1 = strongly disagree; 2 = rather disagree; 3 = generally; 4 = rather agree; 5 = strongly agree	3.810	0.572
Information literacy	Knowledge	X_{11}: You understand the WeChat platform sales process: 1 = strongly disagree=; 2 = rather disagree; 3 = generally; 4 = rather agree; 5 = strongly agree	2.921	1.023
		X_{12}: You can use the WeChat platform to publish orange-related information: 1 = strongly disagree=; 2 = rather disagree; 3 = generally; 4 = rather agree; 5 = strongly agree	3.919	1.263
		X_{13}: You can use WeChat to receive payments: 1 = strongly disagree=; 2 = rather disagree; 3 = generally; 4 = rather agree; 5 = strongly agree	3.064	1.439
	Awareness	X_{21}: You want to sell oranges through the Internet: 1 = strongly disagree=; 2 = rather disagree; 3 = generally; 4 = rather agree; 5 = strongly agree	3.163	0.899
		X_{22}: You spend money to learn about WeChat sales: 1 = strongly disagree=; 2 = rather disagree; 3 = generally; 4 = rather agree; 5 = strongly agree	2.825	1.066
	Ability	X_{31}: You can receive outside information very well: 1 = strongly disagree=; 2 = rather disagree; 3 = generally; 4 = rather agree; 5 = strongly agree	3.106	1.071
		X_{32}: You exchange information about WeChat sales with your friends: 1 = strongly disagree=; 2 = rather disagree; 3 = generally; 4 = rather agree; 5 = strongly agree	2.362	1.229
		X_{33}: You are proficient in operating the WeChat sales process: 1 = strongly disagree=; 2 = rather disagree; 3 = generally; 4 = rather agree; 5 = strongly agree	2.537	1.149
Farmer's characteristics	Gender	Gender of respondents: 1 = male; 0 = female	0.579	0.514
	Age	Age of the respondents (years)	49.475	12.096
	Education	Level of education received: 1 = primary school and below; 2 = junior high school; 3 = high school; 4 = junior college; 5 = college and above	1.659	0.785
	Scale	Orange planting area (ha)	0.476	1.656
	Inyear	Years of using WeChat to sell oranges (years)	4.211	2.234
Policy environment	Policy	You understand e-commerce related policies: 1 = Yes; 0 = No	0.384	0.487
	Training	You have received training on e-commerce: 1 = Yes; 0 = No	0.251	0.434
Village environment	Traffic	Your residence is within 5 km from the town: Yes = 1, no = 0	0.370	0.335
	Logistics	There is an express station in the village: Yes = 1, no = 0	0.503	0.236
	Internet	There is a WiFi network set up at home: Yes = 1, no = 0	0.455	0.353

(4) Other variables: According to the research of existing scholars, we included in the model other factors, such as information literacy, policy environment, and village environment, which may potentially affect farmers' WeChat e-commerce participation and sales performance [5,27,31]. These factors are shown in Table 1. Farmer's gender, age, and education are selected as personal characteristics [32]. Production scale and years of using WeChat are selected as household characteristics [5]. The ability of farmers to obtain rich, timely, and accurate information in the trading market will directly affect individual behavioral decisions. Therefore, we refer to Lima et al. [31] for a measure of information literacy mainly in three dimensions: knowledge, awareness, and ability. If the effect of farmers' information knowledge, information awareness, and information ability on sales performance is positive on all dimensions, it indicates that the more information-literate farmers participate in WeChat e-commerce with better sales performance. In addition, the policies pursued by government departments and training have a greater role in guiding the farmers' decisions [4]. Policy guidance and training may effectively promote farmers' participation in e-commerce. The better the village environment, such as traffic, logistics, and network, the higher the efficiency of e-commerce operations and the better the sales performance of farmers participating in WeChat e-commerce [5].

4. Results and Discussion

4.1. Descriptive Statistical Analysis of Samples

We counted the orange sales channel selection of sample farmers (Figure 1). The results show that the following percentages of farmers sell oranges through traditional offline sales, WeChat e-commerce, and third-party e-commerce: 100%, 37.44%, and 5.67%, respectively. According to the proportion of each channel, it is clear farmers still mainly rely on the traditional channel and are less likely to participate in large-scale formal e-commerce platforms. Meanwhile, we re-counted the proportion of online sales among 152 farmers who use WeChat to sell oranges (Figure 2). We found that the percentage of farmers using the WeChat channel to sell oranges is more than 50%, indicating that there are many small farmers using the WeChat channel to sell oranges. That is, WeChat e-commerce is an important channel for farmers to sell agricultural products, especially for smallholder farmers.
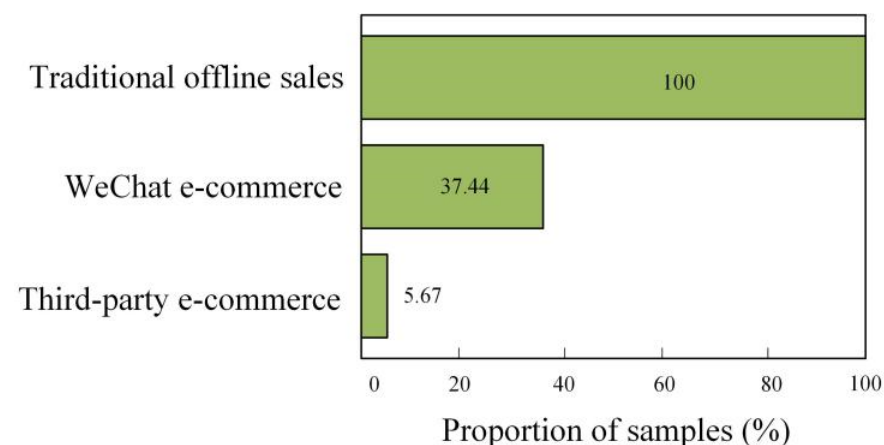

Figure 1. Statistical representation of orange sales channels of sample farmers. Notes: The above statistics are collected from survey data. Traditional offline sales refer to farmers selling oranges through retail, wholesale, supermarkets, and other local markets. Third-party e-commerce refers to the sale of oranges on large formal e-commerce platforms such as Jingdong, Taobao, and pinduoduo.
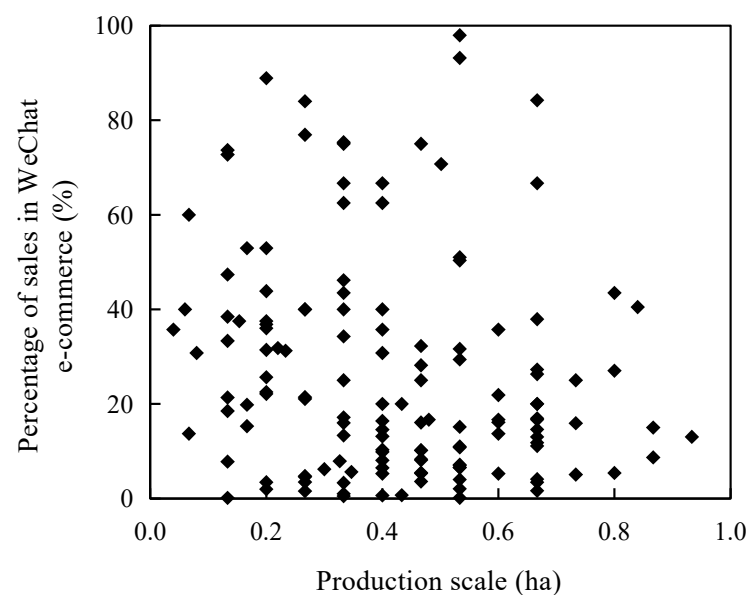
Figure 2. Statistics on the proportion of WeChat e-commerce sales revenue. Notes: The above statistics are collected from survey data. The black diamond indicates the distribution of sample points.

4.2. Reliability and Validity Analysis

SPSS version 22.0 software was used to test the reliability of the multidimensional variables (Tables 2 and 3), and the results show that the factor loading coefficients of each question item are greater than 0.7, composite reliability (CR) is greater than 0.8, and the average variance extracted (AVE) is greater than 0.5, which indicates good model convergent validity. The square root statistics of the average variance extracted (AVE) are all greater than the absolute value of the correlation coefficient among the constructs, which indicates that the model has good discriminant validity. Therefore, the model used in this study has good validity, and the relationships among the variables have some reasonableness and are suitable for further model estimation. In addition, Cronbach's α statistic for each variable is greater than 0.6, which indicates that the measurement scale used in this study has good internal reliability. The overall KMO statistic is 0.794, and Bartlett's spherical test passed the 1% significance test, indicating suitability for factor analysis.

Table 2. Results of factor analysis and reliability test of variables.

Variables	Measures	Factor Loading	Cronbach's α	CR	AVE	Square Root of AVE
Social connections	Intimacy Interaction frequency Trust	0.824 0.753 0.717	0.642	0.809	0.587	0.766
Knowledge	X_{11} X_{12} X_{13}	0.812 0.903 0.900	0.849	0.905	0.762	0.873
Awareness	X_{21} X_{22}	0.885 0.896	0.770	0.885	0.793	0.891
Ability	X_{31} X_{32} X_{33}	0.804 0.897 0.889	0.853	0.898	0.747	0.864

Table 3. Square root of factor AVE and factor correlation coefficient matrix.

Variables	1	2	3	4
Social connections	0.766			
Knowledge	0.264 **	0.873		
Awareness	0.175 **	0.128 **	0.891	
Ability	0.466 **	0.383 **	0.125 *	0.864

Notes: Control variables are not listed in this table. * and ** indicate significance at the statistical levels of 10% and 5%, respectively.

4.3. Analysis of Factors Affecting Farmers' Participation in WeChat E-Commerce

A regression analysis was conducted using the Heckman two-stage model on the sample (Table 4). As the role of government propaganda is mainly to guide farmers' behavior by conveying policy implications, it can be considered as mainly influencing farmers' decision to participate in WeChat e-commerce rather than the share of sales revenue of farmers using WeChat. Therefore, the variable "Policy" was removed from the second-stage regression, satisfying the basic requirements of Heckman's two-stage regression. The inverse Mills ratio coefficient in the regression results passed the 5% significance level test, indicating that the problem of sample selectivity bias of the model exists, and the necessity of the Heckman two-stage regression method was verified.

Table 4. Regression results of factors influencing farmers' participation in WeChat e-commerce.

Variables	First-Stage		Second-Stage		Tobit Regression	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Social connections	0.169	0.172	3.032 ***	0.921	1.348 *	0.780
Knowledge	0.554 ***	0.177	0.842	1.049	0.337	0.880
Awareness	0.357 **	0.168	4.255 ***	1.160	2.267 **	0.974
Ability	0.955 ***	0.237	3.955 ***	1.338	2.227 **	1.085
Age	0.004	0.018	0.112	0.111	−0.015	0.084
Gender	−0.662 *	0.353	1.152	1.846	0.656	1.483
Education	−0.176	0.211	−2.335 **	1.094	−1.830 **	0.896
Scale	0.012	0.047	−0.004	0.022	−0.015	0.017
Policy	0.635 *	0.371			−0.692	1.695
Training	0.145	0.397	−0.691	2.018	−1.820	1.920
Traffic	−0.039	0.284	1.041	1.536	−0.265	1.262
Logistics	−0.016	0.409	2.296	2.345	2.250	1.917
Internet	0.210	0.412	0.885	2.398	4.072 **	1.982
λ			−4.177 **			

Notes: *, **, and *** indicate significance at the statistical levels of 10%, 5%, and 1%, respectively.

The first-stage regression results show that information literacy has a positive impact on farmers' participation in WeChat e-commerce, with knowledge and ability passing the 1% significance level test and awareness passing the 5% significance level test. For rural areas experiencing relative information poverty, farmers with higher information literacy are more incentivized to use WeChat e-commerce. Farmers with greater information knowledge are more effective in obtaining information related to the sale of agricultural products through WeChat e-commerce. This improves their knowledge of WeChat e-commerce and mitigates the information and technical constraints of online sales, reducing the risk and uncertainty of channel selection and promoting the adoption of WeChat e-commerce. The gender of the farmers and the policy passed the 10% significance level test, where the effect of gender was negative. Women are more likely to adopt WeChat e-commerce to sell agricultural products than men, probably because the opportunity cost for men is relatively higher in rural areas of China. Men in rural areas are more willing to use their free time to work outside rather than use WeChat e-commerce to sell agricultural products. The more farmers know about the policy, the easier it is to choose to use WeChat e-commerce.

The second-stage regression results show that social connections positively affect the share of sales revenue of farmers using WeChat at the 1% significance level. The stronger the relationship between farmers and consumers, the higher the loyalty of consumers to the sellers, which directly enhances the share of sales revenue through WeChat [33]. Awareness and ability passed the 1% significance level test and positively influenced the share of WeChat channel sales revenue, while knowledge was not significant. The effects of education on the share of sales revenue from WeChat passed the significance level tests of 5%, and the direction is negative. This shows that farmers' education level negatively affects the share of sales revenue from WeChat, and less-educated farmers are more likely to choose the WeChat channel when they want to develop an online channel.

Although the Heckman model effectively solves the self-selection bias problem, the method is very sensitive to potential heteroskedasticity. Therefore, it is necessary to set up a robustness testing scheme for the regression results. Tobit models, also known as restricted dependent variable models, are suitable for dealing with sample-selection and data-imputation problems and can be used as robustness tests for this paper. The regression results (Table 4) are basically consistent with Heckman regression.

4.4. The Impact of WeChat E-Commerce and Social Connections on Farmers' Sales Performance

Based on Equation (3), we estimated the impact of WeChat e-commerce and social connections on sales performance and further explored the moderating effect. The results are shown in Table 5. Model 2 adds the interaction term between the use of WeChat e-commerce and social connections between farmers and consumers to Model 1. Among them, the sales performance of agricultural products includes sales revenue from offline channels and sales revenue from WeChat e-commerce. On the one hand, participation in WeChat e-commerce has a significant positive impact on sales performance, which passes the significance level test of 1%. On the other hand, the interaction term is significant and positive, indicating that a strong relationship between the farmer and consumers helps increase the effect of WeChat e-commerce on orange sales performance. This verifies this paper's research hypothesis. There is no doubt that participation in WeChat e-commerce is beneficial to the sales of agricultural products by farmers. This result corroborates the views of Ou et al. [33] and Yang and Che [12] that a strong relationship between farmers and consumers can support user and consumer loyalty and promote the sales of agricultural products.

Table 5. Estimation of the impact of WeChat e-commerce and social connections on farmers' sales performance.

| Variables | Sales Performance | | | |
| | Model 1 | | Model 2 | |
	Coefficient	S.E.	Coefficient	S.E.
WeChat e-commerce	0.323 ***	0.100	0.320 ***	0.100
Social connections	0.446 ***	0.038	0.376 ***	0.049
WeChat e-commerce × social connections			0.170 **	0.081
Knowledge	0.017	0.032	0.011	0.032
Awareness	0.062 *	0.033	0.046	0.034
Ability	0.090 **	0.043	0.087 **	0.043
Age	−0.002	0.004	−0.002	0.004
Gender	−0.131 **	0.060	−0.124 **	0.060
Education	−0.057	0.047	−0.058	0.046
Scale	−0.003 ***	0.000	−0.003 ***	0.000
Policy	0.073	0.085	0.083	0.084
Training	0.128	0.100	0.118	0.099
Traffic	0.074	0.060	0.081	0.061
Logistics	−0.047	0.082	−0.055	0.082
Internet	0.044	0.092	0.034	0.092
R-squared	0.437		0.446	
F-test	22.127 ***		22.851 ***	

Notes: *, **, and *** indicate significance at the statistical levels of 10%, 5%, and 1%, respectively.

4.5. Heterogeneity Analysis: Who Will Benefit More from WeChat E-Commerce?

There are great differences in China's regional development level, and farmers there have typical characteristics of a small scale and a low education level. Therefore, we selected three indicators of scale, education, and Internet development to estimate the samples in groups. First, the analysis was grouped by scale. In this study, according to the research of Zeng et al. [18], we used the mean value of planting size as the dividing line to discuss planting size into two sample groups. It is clear that WeChat e-commerce and social connections significantly increase sales performance among large- and small-scale farmers. The interaction term is significant and positive among small-scale farmers but not significant among large-scale farmers. This indicates that the farmer–consumer relationship can reinforce the impact of smaller-scale farmers' use of WeChat e-commerce on sales performance. The reason for this may be that small-scale farmers have limited channel options and customer resources [5]. So, small-scale farmers attach more importance to maintaining consumer relationships. Second, the analysis was grouped by education. The results show that WeChat e-commerce contributes significantly to sales performance, regardless of whether the education level is high or low. The social connections and interaction terms were significant and positive at lower education levels and insignificant at higher levels. A possible reason for this is that weak acquisition of knowledge by less-educated farmers leads to a disadvantage in the marketing process in terms of hard aspects such as operational processes, making farmers more dependent on consumer relations [4]. Third, the analysis was grouped by the level of Internet development. The results show that the effects of WeChat e-commerce on sales performance are significant and positive for farmers with high levels of Internet development. The results of the social connections and interaction terms are the same as the results of WeChat e-commerce. In contrast, WeChat e-commerce and the interaction items did not correlate significantly to sales performance with a low level of Internet development. The above result shows that a higher level of use of popular Internet applications is an important guarantee for the smooth implementation of WeChat e-commerce [5] (Table 6).

Table 6. Heterogeneity results based on group regression.

Variables	Scale		Education		Internet Development	
	Large	Small	High	Low	High	Low
WeChat e-commerce	0.682 **	0.281 ***	0.531 *	0.318 ***	0.318 ***	0.374
	(0.309)	(0.054)	(0.263)	(0.109)	(0.104)	(0.357)
Social connections	0.395 ***	0.383 ***	0.434	0.380 ***	0.336 ***	0.456 ***
	(0.140)	(0.052)	(0.264)	(0.049)	(0.055)	(0.109)
WeChat e-commerce × social connections	−0.024	0.219 ***	0.188	0.164 *	0.203 **	0.492
	(0.189)	(0.078)	(0.295)	(0.090)	(0.086)	(0.343)
Knowledge	−0.020	0.004	−0.021	0.013	0.012	0.085
	(0.108)	(0.035)	(0.079)	(0.035)	(0.033)	(0.117)
Awareness	0.111	0.020	−0.215 **	0.086 **	0.015	0.234
	(0.092)	(0.037)	(0.101)	(0.036)	(0.036)	(0.141)
Ability	−0.070	0.096 **	0.218	0.075 *	0.076 *	0.035
	(0.143)	(0.046)	(0.132)	(0.043)	(0.044)	(0.172)
Age	0.009	−0.004	0.001	−0.002	−0.006	0.033 ***
	(0.010)	(0.004)	(0.009)	(0.004)	(0.004)	(0.012)
Gender	−0.207	−0.085	−0.264	−0.102	−0.112 *	−0.261
	(0.225)	(0.065)	(0.232)	(0.064)	(0.063)	(0.186)
Education	0.138	−0.080 *	−0.043	−0.132 *	−0.074	0.146
	(0.158)	(0.046)	(0.189)	(0.073)	(0.047)	(0.200)
Scale	−0.003 ***	−0.007	0.013	−0.003 ***	−0.003 ***	−0.196
	(0.001)	(0.019)	(0.029)	(0.000)	(0.000)	(0.211)
Policy	−0.094	0.133	−0.116	0.115	0.080	0.224
	(0.247)	(0.089)	(0.265)	(0.087)	(0.089)	(0.263)
Training	0.091	0.136	0.559 *	−0.008	0.074 *	0.403
	(0.362)	(0.096)	(0.323)	(0.103)	(0.103)	(0.350)
Traffic	0.201	0.023	0.477 **	0.042	0.069 **	0.134
	(0.188)	(0.064)	(0.227)	(0.065)	(0.067)	(0.191)
Logistics	−0.266	0.012	−0.634 **	0.020	−0.077 **	0.182
	(0.281)	(0.089)	(0.261)	(0.088)	(0.086)	(0.285)
Internet	0.325	0.038	0.364	−0.010	0.040	−0.134
	(0.370)	(0.101)	(0.417)	(0.087)	(0.105)	(0.231)
R-squared	0.485	0.365	0.560	0.457	0.442	0.637
F-test	17.060 ***	6.135 ***	4.561 ***	20.729 ***	18.551 ***	6.098 ***

Notes: *, **, and *** indicate significance at the statistical levels of 10%, 5%, and 1%, respectively. The values in brackets are standard errors. Farmers with a scale greater than 0.67 hectares were classified as large-scale farmers, while others were small-scale farmers. Considering the relatively low literacy level in rural areas, we classify less than junior high school as low literacy and others as high literacy. When WiFi network is set up at home, the farmer is considered a part of the high Internet development group.

4.6. Mechanism Analysis: How Can WeChat E-Commerce Increase Sales Performance?

To explore the mechanism of WeChat e-commerce affecting farmers' sales performance, we successively estimated the impact of farmers' participation in WeChat e-commerce on their sales quantity, unit cost, profit rate, and family income (see Table 7 for the results). First, it is clear WeChat e-commerce has a significant positive effect on sales quantity, profit rate, and family income, while the effect on unit costs is not significant. In reality, we can see that production costs are mostly reflected in the planting process, and farmers do not need to pay additional transaction costs for WeChat channels. A beneficial effect of WeChat e-commerce is that it can increase the sales quantity and profit rate; that is, the commercialization rate and market value of oranges can be significantly improved. These are also key to improving farmers' sales performance. The results also show that social connections have a significant positive effect on sales quantity and family income but not on unit cost and profit rate. Moreover, social connections play a positive moderating role in WeChat e-commerce in promoting sales quantity and family income. This finding corroborates the proposal of Li et al. [1] and Tang and Zhu [9], whereby rural e-commerce helps boost income in developing countries. Strong social relations can increase the online sales quantity of WeChat e-commerce and help farmers sell more agricultural products.

Table 7. Impact of WeChat e-commerce on sales quantity, unit cost, profit rate, and family income.

Variables	Sales Quantity (kg)		Unit Cost (10,000 CNY/ha)		Profit Rate (%)		Family Income (10,000 CNY)	
WeChat e-commerce	6.337 ***	6.335 ***	0.136	0.137	28.009 *	27.977 *	0.287 **	0.287 **
	(0.369)	(0.368)	(0.120)	(0.121)	(16.227)	(16.271)	(0.130)	(0.130)
Social connections	0.143 *	0.012	0.043	0.100 *	5.921	3.126	0.085 *	0.149 **
	(0.092)	(0.043)	(0.043)	(0.053)	(7.880)	(8.521)	(0.047)	(0.059)
WeChat e-commerce × social connections		0.380 *		0.139		6.854		0.157 *
		(0.221)		(0.082)		(16.739)		(0.087)
Knowledge	0.307 ***	0.293 ***	0.019	0.024	7.386	7.145	0.061	0.066
	(0.105)	(0.104)	(0.037)	(0.038)	(7.623)	(7.669)	(0.046)	(0.047)
Awareness	0.300 ***	0.266 ***	−0.002	0.011	7.576	6.967	0.025	0.039
	(0.093)	(0.090)	(0.039)	(0.04)	(6.625)	(6.506)	(0.046)	(0.047)
Ability	0.616 ***	0.61 ***	0.112 **	0.114 **	8.725	8.618	0.173 ***	0.176 ***
	(0.146)	(0.145)	(0.055)	(0.055)	(8.737)	(8.771)	(0.062)	(0.062)
Other variables	Control	Control	Control	Control	Control	Control	Control	Control
R-squared	0.810	0.812	0.049	0.056	0.033	0.034	0.106	0.112
F-test	492.447 ***	409.434 ***	4.867 ***	4.725 ***	2.460 **	2.060 **	9.588 ***	8.519 ***

Notes: *, **, and *** indicate significance at the statistical levels of 10%, 5%, and 1%, respectively. The values in brackets are standard errors. The unit cost of orange includes planting cost, management cost, sales cost, and so on.

5. Conclusions and Policy Implications

Rural e-commerce is a marketing model in the context of the new era, which is crucial for farmers' income enhancement and rural economic development. The easy-to-operate social media WeChat is widely used in China, expanding e-commerce channels. However, few studies have argued for the beneficial nature of e-commerce supported by WeChat. Based on survey data from Hubei Province, China, we explored the influencing factors of farmers' selling behavior in WeChat and empirically analyzed its impact on sales performance. Our findings will help countries similar to China make better use of social media to develop e-commerce and help policy makers provide new ideas for the development of rural e-commerce using large platform e-commerce models.

The main findings of this paper are as follows: First, information literacy, social connections, farmer characteristics, policy environment, and village environment impact farmers' WeChat e-commerce participation. Among them, information awareness, social connections, education, years of using WeChat e-commerce, and Internet development in villages are important factors that affect the share of sales revenue of WeChat e-commerce. Second, local governments can give farmers special training on different e-commerce models so that they can understand the differences and specific operations of different e-commerce models, such as WeChat e-commerce and platform e-commerce. In this way,

farmers can choose a more suitable e-commerce model for themselves when participating in rural e-commerce. Third, WeChat e-commerce can increase the quantity of sales and profit rate; that is, the commercialization rate and market value of oranges can be significantly improved. These are the main reasons why WeChat e-commerce can improve farmers' sales performance.

Based on the conclusions drawn from this study, we offer the following policy insights: First, local governments should cultivate information awareness, information knowledge, and the information-retrieval ability of farmers by providing more training opportunities. In this way, farmers can play a more active role in the development of rural e-commerce. Second, WeChat e-commerce could be promoted to increase the enthusiasm of smallholder farmers to participate in rural e-commerce. It is encouraging to let smallholder farmers sell agricultural products through the WeChat social platform and promote the use of WeChat e-commerce. Third, the social connections of farmers can be better used to increase the sales channels of agricultural products and improve sales performance. Using "acquaintance society" to carry out commodity sales can effectively avoid the defects of farmers' marketing ability. Fourth, some regions with a high level of Internet development can be selected as pilots for WeChat e-commerce development. At the same time, local governments should strengthen the Internet infrastructure in rural areas, especially in poor mountainous areas. This will enhance the ability of farmers to use information technology.

However, this study also has some limitations. Firstly, due to the constraints of research time and resources, the sample data of this study mainly come from navel orange farmers in Yichang City, Hubei Province, and the sample fails to cover the whole country. Secondly, this paper mainly explores the direct participation of farmers in e-commerce using WeChat and does not discuss in depth the indirect sales model of cooperatives and other agricultural organizations, which still needs to be further researched and discussed by scholars in the future.

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