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Drivers of Online Retailing Performance of Agricultural Products in Rural China

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Abstract

In the era of digital economy, it has become an important part of the digital transformation of the agricultural industry to promote the sound development of agricultural e-commerce. Based on sample data covering five provinces one municipality directly under the central government of China, the paper empirically analyzes the internal and external factors affecting online retail of agricultural products. The results show that park policies, business environment, market and other external factors significantly affect the online retail performance of agricultural products under the condition of controlling the characteristics of individual operators and products. However, the brand of agricultural products is still the key factor determining online retail performance. In addition, the mediating effects of new media communication on the relationship between external factors and online sales of agricultural products was significant. The research results can provide reference for further exploring the roles of government, market and new media technologies in boosting the development of agricultural e-commerce.

JEL Codes: Q12

1.Introduction

As China's digital economy is gaining momentum, the era of digital China has arrived. According to the *White Paper on the Development of China's Digital Economy*, China's digital economy had been booming in 2020, amounting up to RMB39.2 trillion or 38.6% of the GDP, up 2.4 percentage points year-on-year[1]. Experts and officials estimate that China's digital economy will exceed 50% of the GDP by 2025 and China will enter an era of digital economy[2]. Socially, China's Internet users have risen sharply from 153 in 1993 to over 900 million in 2021. Of them, 99% used mobile terminals to access the Internet. By 2021, China boasted the world's largest fiber optic network, the largest number of 4G and 5G base stations and the widest coverage of digital technology users, with e-commerce applications covering areas and natural village teaching points that had been previously the least likely to be covered. The fast development of Internet technology and infrastructure has created conditions for the digital transformation of industries, while the COVID-19 pandemic has forced the primary, secondary and tertiary industries to expedite their digital transformation, with the penetration of digital economy being 8.9%, 21.0% and 40.7% respectively in China's agriculture, industrial and service sectors in 2021. These efforts have also provided vast space for the development of digital economy[1]5.

The digital transformation of the agricultural sector has had a profound impact on China's agricultural production, supply and marketing system. In particular, it has acted as a shock to the traditional sales model of agricultural products and served as a booster for the fast development of agricultural e-commerce. Data show that the 2011-2020 total social consumption in rural areas was higher than that in urban areas[1]. Despite being affected by the pandemic, a wide range of industries involved in rural live commerce have injected new impetus into agricultural e-commerce. China's online consumption of agricultural products reached 397.5 billion yuan in 2019, surging to 610.7 billion yuan in 2020[2]. In 2020, 2.96 million active online stores in 5,425 Taobao villages nationwide created 8.28 million jobs[3]. A total of 2,120 public service centers and logistics distribution centers for e-commerce and 137,000 village-level e-commerce service sites have been built nationwide[4]. Live commerce, farming platforms, micro business, short-video e-commerce, social commerce and other new media platforms are developing rapidly to become important channels for the sale of agricultural products, playing a vital role in boosting the two-way circulation of urban and rural commodities, facilitating the balanced development of urban and rural areas and realizing rural vitalization.

Since 2014, the central government has issued a series of action plans, guidelines and laws and regulations to support the development of rural e-commerce, putting forward measures to strengthen its development in terms of policy support, infrastructure, logistics & transportation, talent training, quality & safety, and market environment. All the efforts have created a favorable external environment for the e-

[1] Source: China's National Bureau of Statistics.
[2] Source: Smart E-commerce Institute of China Agricultural University and iResearch
[3] Source: AliResearch.
[4] Source: Qianzhan Data Institute.

commerce retail of agricultural products[3]. From the central to local governments, the "Internet plus" program for the online retail of agricultural products, the comprehensive demonstration of rural e-commerce, and the scheme of "digital countryside" have been implemented to integrate agriculture and rural areas with digital technology and boost the development of agricultural e-commerce. Unlike the traditional offline channels for selling agricultural products, the e-commerce model realizes the flat connection between business and consumer (B2C) and consumer and consumer (C2C) through the Internet, thus reshaping the agricultural sales model and facilitating the restructuring and upgrading of the value chain for agricultural products. In this process, digital infrastructure, logistics & transport, new media technology and e-commerce operators have all become key elements of e-commerce development. So, what roles do the government and the market play in promoting the development of agricultural e-commerce in the era of digital economy? Or how do the internal and external factors affecting the development of agricultural e-commerce play their roles? The answers to the above questions provide a basis for accurately identifying the key factors that promote the development of agricultural e-commerce. More importantly, they can provide a decision-making basis for the government to further improve its policy support for rural e-commerce.

2. Literature Review

(1) Agricultural e-commerce and farmers' income

Back in the 1970s[4], researchers have focused on the relationship between rural e-commerce and information technology, realizing the new significance of rural e-commerce in transforming rural development. R. Kalakota & B. Winston (1997) defined rural e-commerce as the process of using the Internet and telephone lines to deliver rural goods and services and pay for them. It serves as an important tool for reducing intermediate costs and improving service quality[5]. Tigre & Dedrick (2003), after examining and comparing the current situation and trends of agricultural operations in many countries, concluded that the policy support has an incentive effect on rural e-commerce in developing countries and that resources can be more fully utilized through the Internet, which helps to unite scattered agricultural self-employed units[6]. Domestic research on rural e-commerce has come late, which is inextricably linked to China's lagging Internet economy. Early scholars in this field, such as Su Qizhi (2007), believed that rural e-commerce links the pre-production, production and post-production stages, which helps to reduce the production cost of agricultural products, optimize the structure of agricultural production and align modern agriculture with international agricultural markets[7]. Yue Yunkang (2008), taking Jiangsu rural supermarket chain platform as an example, elaborated on the relationship between online retailers of agricultural products and the use of information technology resources, proposing that the Internet and information technology be used to transform the distribution system for agricultural products[8]. It can be seen that the early research at home and abroad focused on the production, circulation and sales of agricultural e-commerce and the problem concerning how to apply information technology in this regard.

With the further development of the Internet plus initiative, the form, scope and extent of rural e-commerce has been enhanced. It is self-evident that rural e-commerce is of significant importance to rural vitalization and urban-rural integration development. On the whole, rural e-commerce contributes to cutting distribution and sales costs and market transaction charges. Meanwhile, Han Meng (2017) pointed out that rural e-commerce, driven by the Internet economy, can also interconnect the information flow, commercial flow and capital flow in urban and rural areas and improve the commercialized performance of agricultural resources[9]. Lin Haiying et al. (2020) argued that rural e-commerce has a significant effect on farmers' income increase, representing an important way to achieve an effective linkage between rural vitalization and the development of households after targeted poverty alleviation[10]. This viewpoint has been corroborated by relevant studies. Ma Biao et al. (2021) showed that agricultural e-commerce had a significant contribution to the improvement of agricultural income of family farms. The effect of increasing the revenue of family farms at low- and middle-income levels was significantly better than that of the farms at middle and high levels[11]. According to a case study of companies on the ByteDance platform[12], the poverty alleviation efforts conducted by these enterprises have created pluralistic value directly for enterprises and needy farmers in poverty-stricken areas, mainly including enhanced income, empowered capacity and expanded relationships. During the period of poverty alleviation, the central and local governments had utilized e-commerce and consumption to mobilize enterprises and NGOs to participate in poverty eradication and continue to play a significant role in rural vitalization.

(2) Factors affecting the development of agricultural e-commerce

By giving into play the key role of rural e-commerce and agricultural e-commerce in rural economy and farmers' income, studies have also begun to focus on how to promote the sound development of agricultural e-commerce, which also involves exploring the role of government and market. Based on the existing literature, the factors affecting the development of agricultural e-commerce are focused on two clues: first, the quality characteristics of operators; second, the development environment of agricultural e-commerce[13]. The former includes the characteristic factors such as cultural quality, skill level, network awareness and innovation linkage of business entities. Meanwhile, as farmers are the main participants of agricultural e-commerce, their knowledge, skills, and abilities to accept and apply the Internet will directly impact the development of agricultural e-commerce[14-16]. In this process, the leading role of start-up owners and the demonstration role of online retailers should not be disregarded. According to the theory of industrial cycle, start-up owners play a pioneer role in the early and middle stages of agricultural e-commerce. They can muster the enthusiasm of their surrounding people and villagers to participate in agricultural e-commerce[17]. The model retailers include a pool of talents engaged in agricultural science and technology, sales and operation, production and services, and media operation[18-19] . They have become the main professional forces of agricultural e-commerce. The current research on the role of start-up owners and online retailers is on the increase, but the importance of policy-based guidance is easily overlooked in related studies.

Compared to the previous study that focused on individual retailers, the latter pays more attention to the external environment of agricultural e-commerce in the four aspects of policy support, new media technology, infrastructure and market environment. Since 2014, the annual No. 1 central document has proposed to advance the development of rural e-commerce. In this sense, policy-based guidance and support is particularly important. Government policies have played an irreplaceable role in mobilizing the participation of multiple entities and facilitating the flow of capital, technology, talent, logistics, media and other factors into rural areas. Even Western countries that promote less government intervention and encourage a free economy value the orientation of e-commerce policies[20]. Xiao Kaihong et al. (2019) used textual analysis to study the evolution of agricultural e-commerce policies at the national level, finding that national policies range from directional guidance, encouragement and adoption at the early stage, via the refinement to specific application areas during the start-up period, and finally to practice during the growth period[21]. It was found that the decision-making orientation of China's agriculture-related e-commerce is more precise and refined[22] Tang Yueheng et al. (2020) also found that the comprehensive demonstration policy of e-commerce in rural areas could improve farmers' income[23]. Even so, it is still necessary to study how the "visible hand" or policies and measures of the government to promote the development of agricultural e-commerce needs to intervene.

New media technology and communication have an enormous impact on the development of agricultural e-commerce. As early as the start of the 20th century, foreign research began to anticipate the role of media technology in the development of e-commerce. G. Baourakis & Kourgiantakis (2002) contended that agricultural e-commerce needs to be developed based on information technology to leverage the Internet and media technologies in agricultural business[24]. New media technology plays a significant role in reducing the rising cost of agricultural products, shaping consumer hotspots, and unleashing the potentials of economic development, among other things. Considering the development trend, new media technology and rural e-commerce are becoming more integrated, thanks to the advancement of the new technology revolution. Live commerce, farming platform, micro business, short video e-commerce and social commerce have utilized new media technologies, representing one of the most crucial features of the current agricultural e-commerce in rural areas. In terms of development impact, new media platforms have played an important role in assisting less developed regions and ethnic regions in achieving rural vitalization and common prosperity[25-26].

The infrastructure impacting the development of agricultural e-commerce includes supporting facilities covering roads, network communication and logistics, of which more scholars focus on studying the logistics system. Express delivery service points, logistics network, distribution model and cold chain supply technology are the main links in the logistics system. Ma Xiaoya (2016) argued that the main constraint of the small sales scale effect of agricultural e-commerce is the incomplete distribution of the logistics end, with distinctive agricultural products not directly accessible to the market[27]. Ling Hong (2017) pointed out that rural e-commerce transactions are fresh agricultural and livestock products, and the transportation distance and cold chain logistics technology will affect the development of rural e-commerce[28]. The logistics system itself is also the process of transferring the flow of goods and

information between urban and rural areas. It can help release new information in rural areas continuously, consolidate the achievements of rural poverty eradication, and promote the urban-rural development[29]. In addition, the logistics system and network system will be developed in a coordinated manner to enhance network coverage and network utilization rate and improve information technology services so as to bring more development opportunities for the horizontal promotion and vertical extension of agricultural e-commerce.

The ultimate goal of agricultural e-commerce focuses on the orientation to the market. The market environment will impact the scale, scope and level of production and sales of agricultural products. The seasonal characteristics of agricultural production suggest that prices of agricultural products are a barometer of the market environment. As the Internet economy is being further advancing, the current research on the market environment has focused on two aspects, namely market services and market structure. In terms of market services, the research is reflected in financial services. In the development of rural e-commerce, there are widespread problems such as poor investment and financing channels of e-commerce and few types of credit products. To address the problems, Cao Lingling et al. (2017) advocated opening more financial channels for rural areas based on policy-based finance, commercial finance, cooperative finance and e-finance, so as to offer more financial services to agriculture, rural areas and farmers[30]. In terms of market structure, the production of agricultural products needs to meet the changing demands of the market structure to carry out the required primary processing or moderately deep processing. Emphasis needs to be placed on product quality to standardize and brand existing agricultural products[31] to meet the needs of agricultural e-commerce.

In summary, both domestic and international literature has affirmed the role and prospect of rural e-commerce. The factors influencing agricultural e-commerce have been discussed in many aspects and at many levels. However, the current research has focused on innovations from a single perspective, while few studies have addressed the interaction between influencing factors and even fewer quantitative studies have been conducted in this regard. On this basis, this study employs the quantitative analysis to verify the role of policy support and new media communication in the development of agricultural e-commerce from the perspective of policy support and new media technology. The paper explores the role of government, market and technology in facilitating the development of agricultural e-commerce, providing a basis for decision making to promote the digital transformation of the agricultural industry and modernize agriculture and rural areas.

3. Data, methods and variable selection

(1) Data sources

The data for empirical studies come from the Survey of Rural Talent Training Needs launched by China Agricultural University. In January and February 2021, the survey was conducted in five provinces and one city, namely Guangdong, Shanxi, Jiangxi, Chongqing, Sichuan and Gansu. Affected by the epidemic. The research was completed using an online questionnaire system. For regional factors, we

choose five provinces and one municipality directly under the central government: Guangdong in the east part of China, Shanxi and Jiangxi in the middle, and Gansu, Sichuan and Chongqing in the west. In addition, they have a certain foundation for the development of agricultural products e-commerce as a demonstration region for "pioneers of rural start-ups" rated by China's National Administration for Rural Vitalization. A simple random sampling method was used for selecting rural operators in five provinces and one city. The questionnaire was distributed via the talent training system of local rural vitalization bureaus. In the preliminary stage, we discussed the questionnaire settings with local heads of talent training to ensure that the questions were explicit and accurate. The final 669 questionnaires were collected from the online research, of which 633 were valid, with an efficiency rate of 94.6%. The survey includes their personal and family information, start-up, business environment, the operating status of main products, transport infrastructure and training needs.

(2) Model setting

The core issue of this paper is about how the internal and external factors of e-commerce operators work through new media technologies to bring about the growth of e-commerce sales of agricultural products. Since the dependent variable is a fixed-order discrete variable, it is suitable to adopt an ordered Logit model to conduct regression estimation. The basic form of the model is as follows:

$$ratio_i = \beta_0 + \beta_1 X_i + \gamma_0 Z_i + \varepsilon_i \quad (1)$$

In the above equation, $ratio_i$ represents the proportion of online sales to the total, X_i a series of variables for external environmental factors, Z_i the control variables affecting e-commerce sales, β_0 a constant term, β_1 and γ_0 the parameters to be estimated for the explanatory and control variables, and ε_i the disturbance term.

Considering that external factors can influence online sales through the mediating variable of new media communication, it is necessary to test the mediating effect of new media communication. According to the method of Wen Zhonglin[32] et al., recursive equations are established for estimation. The basic model is set as follows:

$$M_i = \alpha_0 + \alpha_1 X_i + \alpha_2 Z_i + \delta_i \quad (2)$$

$$ratio_i = c_0 + \gamma_1 X_i + \gamma_2 M_i + \gamma_3 Z_i + \vartheta_i \quad (3)$$

Wherein M_i indicates whether an operator conducts new media communication activities.Equation (2) is the regression equation between the mediating variable and the independent variable, and Equation (3) is that between the dependent variable and the independent and mediating variables. According to the sequential test method, first, test whether the regression coefficient β_1 is significant or not. Second, test the coefficients α_1 and γ_1; if both are significant, then test γ_2; if at least one of them is not significant, the Sobel test is done. Third, the significance of the coefficient γ_2 determines whether the mediating effect is

significant or fully mediated, and the significance of the Sobel test determines whether the mediating effect is significant or insignificant.

(3) Variable selection

The dependent variable in this study is the online retail performance of agricultural products. The indicator is the proportion of online sales in the total, which is measured using the fixed-order method of four levels, including 0, 0-20%, 20%-50%, and 50% or more. The independent variables include factors from government, market, technology and individual operator. In other word, there are both external environmental factors and internal factors of e-commerce business of agricultural products. Specifically, factors of the external environment include park policies, business environment, capital sources, location and market. The internal factors are the quality of individual e-commerce operators and product characteristics. New media communication, a mediating factor, connects producers, operators and consumers directly to compress the supply chain for agricultural products and reorganize the value chain. To this end, we used a mediating effect model to estimate the impact of internal and external factors on agricultural e-commerce through new media communication.

Policy support in the external environment is measured using park policies concerning whether the place of operation is in an e-commerce park, a Taobao village or a start-up park. According to the previous policies, the country and local governments have introduced different policies to support the development of rural e-commerce, including the establishment of corresponding industrial parks or e-commerce platforms, providing operators with preferential policies such as sites, taxes, and information, training and other services. The business environment is measured using respondents' overall evaluation, being rated as very poor, not so good, moderate, relatively good, and very good, respectively. The main funding sources of operators starting up their businesses somehow reflect their local financing environments, with four types of variables including self-owned funds, financing loan, borrowing, and other channels. Location conditions refer to the time taken from the place of business to the most frequently used transport hub. Markets, represented by the areas where consumers come from, are in five provinces and one city, and inside and outside China. Regarding internal factors, the characteristics of individual operators include gender, age, educational background, and work experience. The characteristics of products are about whether a product has been registered as a brand. The mediating variables are about whether an operator has utilized the Internet to conduct commercial communications via enterprise websites, live streaming, WeChat official accounts or Weibo accounts. The core hypothesis is that operators achieve the growth in online sales of agricultural products via new media communication intermediaries, influenced by internal and external factors. For the sake of clarity, the types, names and definitions of variables and descriptive statistics are shown in Table 1.

Table 1 Variable Definitions and Descriptive Statistics

Type of variable	Name of variable	Definition of variable	Observation value	Average value	Standard deviation	Minimum value	Maximum value
Dependent variable	Proportion of online sales in the total	Proportion of online sales in the total, 1=0 (No sales), 2=0-20%, 3=20%-50% and 4=50% or more	633	1.95	0.93	1	4
Independent variable							
External environment	Industrial park	Doing business in e-commerce parks, Taobao villages or related start-up parks, 1=yes, 0=no	633	0.20	0.40	0	1
	Business environment	Overall evaluation of local business environment, 1=very poor, 2=not so good, 3=moderate, 4=relatively good and 5=very good	633	3.89	0.91	1	5
	Funding sources	The main sources of funding for start-ups, 1=self-owned funds (including those from co-founder(s)); 2=financing loan (financial institutions); 3=borrowing (private institutions/friends and relatives); and 4=other channels (government support funds, etc.)	633	1.90	1.13	1	4
	Location	Time spent (hours) from the place of business to the most frequently used transport hub	612	1.61	2.68	0.02	24
	Customer distribution	Distribution of main customers (consumers) for products/services, 1=within a province; 2=inside and outside China; and 3=intermediary purchase (unclear)	633	1.54	0.60	1	3

Mediating variable	Internet-based promotion	Whether the Internet has been used for promotion (such as corporate websites, microblogs, WeChat official accounts, live streaming, etc.) 1=yes, 0=no	633	0.43	0.50	0	1
Control variable							
Characteristics of individual operator	Gender	Gender of an operator, 1=male, 0=female	633	0.80	0.40	0	1
	Age	Age of an operator, 1=under 25, 2=26-35, 3=36-45, and 4=above 45	633	3.01	0.84	1	4
	Educational background	Educational background of operators, 1=junior high school and below, 2=high school/technical secondary school, 3=junior college, 4=bachelor's degree, and 5=master's degree or above	633	2.42	0.98	1	5
	Position	Past or current position, 1=official; 2=Enterprise staff; and 3=None of the above	633	1.81	0.73	1	3
	Experience of migrant workers	Experience of migrant workers (meaning that the accumulated working time of migrant workers across the townships or towns where their households are registered is more than six months), 1=yes, 0=no	633	0.68	0.47	0	1
Product brand	Registered brand	Main products have been registered as a brand, 1=yes, 0=no	633	0.43	0.50	0	1
Regional characteristics	Regional variables	Provincial-level regions: 1=Shanxi; 2=Jiangxi; 3=Sichuan;	633	3.74	1.50	1	6

		4=Gansu; 5=Chongqing; 6=Guangdong					

Note: some variables have missing values.

4. Impact of external environment and new media communication on online retail of agricultural products

(1) Descriptive statistical analysis

According to the description of statistical results, the low proportion of online sales indicates that there is still a large potential and space for the development of agricultural e-commerce. Of 633 operators, 39% had zero online sales. In other words, they did not sell their products through e-commerce. 33.5% of the operators had sold 0-20% of their total. 20.5% of them had 20-50% of their total sales. Only 7% had sold 50% or more of the total. On the whole, there is a certain foundation for the development of agricultural products e-commerce in sample areas. 61% of rural operators have sold their agricultural products through the Internet. However, the proportion of online retail is low. As such, there is a need of large potentials for the further enhancement of online retailing. 86% of the respondents primarily deal in agricultural products, including fruits and vegetables, livestock and poultry products and processed agricultural products. 14% of them sell non-agricultural products.

The research results reveal that there is a positive correlation between the characteristics of business premises in the external environment and online sales of agricultural products. 20% of the operators' business premises are located in industrial parks, start-up incubators, science and technology parks, e-commerce parks and Taobao villages. Operators whose business premises are in parks also have a higher proportion of online sales. Table 2 shows that 83.9% of operators in parks had online sales to a varying degree and so did 55.4% of non-park operators, meaning that operators in parks have higher online sales than non-park ones. In fact, local governments have also introduced corresponding policies to support the development of rural e-commerce as the central government has vigorously promoted e-commerce in rural areas. Industrial parks have also been developed as an effective policy for counties to advance rural e-commerce, thanks to their strong agglomeration effect. For example, China has implemented a comprehensive demonstration program for rural e-commerce since 2014 by constantly improving the rural trade circulation system. Rural online retail turnover and online retail turnover of agricultural products are important evaluation indicators.

Table 2 Number and Proportion of Operators by E-Commerce Park and Online Retail Turnover of Agricultural Products (X and Y)

E-commerce parks/Taobao villages and related start-up incubators	1=0	2=0-20%	3=20%-50%	4=50% or more	Total
Not in a park	227	168	88	26	509
Proportion (%)	44.6	33.01	17.29	5.11	100
In a park	20	44	42	18	124
Proportion (%)	16.13	35.48	33.87	14.52	100
Total	247	212	130	44	633
Proportion (%)	39.02	33.49	20.54	6.95	100

Besides, the results of the analysis unveil that the use of the Internet for live streaming, dissemination and other business activities also helps to increase the online retail sales of agricultural products. As an important link to facilitate online sales, new media communication is indispensable. From the early establishment of enterprise websites, microblogs, WeChat official accounts to the current stage of Douyin accounts, video production and live streaming, new media technology brings new development space for agricultural e-commerce. According to the results, the proportion of online sales of operators who used the Internet to hold new media communication activities is significantly higher than that of those who did not. Table 3 shows that the total proportion of online sales of operators who used the Internet to conduct new media communication activities is 87.9%, while that of those who did not is 40.6%. Accordingly, 214 (59.4%) of the operators who did not carry out communication reported that their online sales made up zero percentage. To put another way, they did not realize online sales, while the proportion of operators who carried out new media communication activities was only 12.1%.

Table 3 Number and Proportion of Operators by New Media Communication and Online Sales (M and Y)

Internet-based promotion	1=0	2=0-20%	3=20%-50%	4=50% or more	Total
No	214	102	33	11	360
Proportion (%)	59.44	28.33	9.17	3.06	100
Yes	33	110	97	33	273
Proportion (%)	12.09	40.29	35.53	12.09	100
Total	247	212	130	44	633
Proportion (%)	39.02	33.49	20.54	6.95	100

There is also a significant correlation between the characteristics of individual operators and products and online sales of agricultural products. For example, operators with registered agricultural brands have

significantly higher online sales than those without brands. Table 4 shows that the proportion of online sales of operators with brands is higher than that of those without brands in three ranges: 0-20%, 20-50% and above 50%. In the meantime, the descriptive statistical analysis unveils that characteristics of individual operators such as educational background and work experience were positively related to online retail of agricultural products.

Table 4 Number and Proportion of Operators by Agricultural Product Brand and Online Sales

Agricultural product brand	1=0	2=0-20%	3=20%-50%	4=50% or more	Total
None	202	109	40	11	362
Proportion (%)	55.8	30.11	11.05	3.04	100
Yes	45	103	90	33	271
Proportion (%)	16.61	38.01	33.21	12.18	100
Total	247	212	130	44	633
Proportion (%)	39.02	33.49	20.54	6.95	100

(2) Model analysis results

1. Benchmark model. The results of the above descriptive statistical analysis provide us with a clear picture of correlations. To further verify the research hypothesis on the factors affecting the online sales of agricultural products, this paper adopts the analysis of econometric model to verify them. Based on the model setup, the model was first estimated using ordinary least squares (OLS). Model (1), a benchmark model, aims to verify the influence of external environmental factors on the share of online retail of agricultural products. Model (2) is the result of model estimation after adding the characteristics of individual operators and products. To avoid multicollinearity problems in the model, the variance tolerance method (the inverse of the VIF value) was used for testing. The test results showed that the mean VIF value of all independent variables was 1.24 (less than 10), and the 1/VIF value of each independent variable was greater than 0.1. As such, it could be judged that there was no multicollinearity problem in the model.

The results of model (1) indicate that the factors of industrial park, business environment and market in the external environment have a significant contribution to the online sales of agricultural products without controlling for the characteristics of individual operators and products. Model (2) reveals that under the condition of adding control variables, the factor of location is not significant, while other factors such as industrial park, business environment and customer distribution are still significant. Specifically, operators located in industrial parks will see a significant increase in the proportion of their online sales of

agricultural products. The better the business environment evaluation, operators will also have a significant increase in the proportion of online sales. Operators whose customers are distributed throughout and outside the country will see significantly higher online sales than those whose consumers are only within a province. The impact of funding sources is embodied in the different effects of various sources of funds on online sales. Operators whose start-up funds come from borrowings may somehow reduce their online sales compared to their own funds. It is also easy to understand that if an operator's funding sources is in a state of borrowing, the funds invested in new business activities are bound to be squeezed, thus affecting its online retail performance.

In addition, personal characteristics that reflect the quality and ability of operators, such as gender, age, educational background and work experience, will significantly affect the proportion of online sales of agricultural products. The online retail performance of rural male operators is inferior to that of female ones, which is similar to what has been studied. The penetration of new online media technology in rural areas has not only reshaped rural business models, but more importantly created new spaces for rural women's empowerment and development. Rural women are increasingly appearing on live streaming platforms and media campaigns and are generating more income by running e-commerce businesses[33]. Of course, the older an operator, the lower the proportion of online sales. The educational background and work experience have a significant positive effect on the proportion of an operator's online sales. From this point of view, it is clear that the digital economy requires a higher level of quality and competence for workers engaged in e-commerce, as evidenced by higher requirements for their educational background, awareness & vision, and youthfulness. Of course, the quality of products directly sold in the market is also important. Whether in the traditional market space or the online sales space of digital economy, brand and quality hold the key to the market sales. This point is supported by the results of model, which show that operators with registered product brands have significantly higher online sales than those without any ones.

As for the importance of factors affecting the online sales of agricultural products, the regression coefficients of model (2) show that brand, consumer distribution, industrial park and operator's work experience have the greatest influence on online sales, with their values being 0.5080, 0.3382, 0.2613 and 0.2665, respectively. This means that the impacts of the four factors on the proportion of online sales decrease in turn. However, their impacts are higher than those of other factors. This shows that e-commerce operation is still a market behavior and market-oriented product brands and consumer distribution directly determine the online retail performance. From the perspective of policy factors, the industrial park policy and the cultivation of e-commerce operators are undoubtedly the direction for the government to promote the development of rural e-commerce.

To further verify the robustness of the model, the ordered Logit model is also estimated in this paper. Model (3) is the estimation result of the ordered Logit model. The regression coefficient values of each variable and the significant levels are consistent with the estimation results of the ols model, which are not repeated here.

Table 5 Analysis of Factors Influencing the Proportion of Online Retail of Agricultural Products

Variable	Model (1) ols		Model (2) ols		Model (3) ologit	
External factors	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Industrial park	0.6231***	0.0949	0.2665***	0.0866	0.6295***	0.2012
Business environment	0.0936**	0.0384	0.1222***	0.0372	0.2944***	0.0984
Sources of funds (compared with self-owned funds)						
2=Financing loan	-0.0803	0.1027	-0.0648	0.0917	-0.2032	0.2341
3=Borrowing	-0.2299**	0.1087	-0.1613*	0.0968	-0.5754**	0.2692
4=Other channels (government support and venture capital)	-0.1981*	0.1038	-0.1222	0.0917	-0.3293	0.2454
Location	0.0198*	0.0108	0.0109	0.0098	0.0301	0.0236
Customer distribution (with a reference to regions in a province)						
2=Inside and outside China			0.3382***	0.0771	0.8068***	0.1845
3=Intermediary purchase (unclear)			-0.2103**	0.1057	-0.7143*	0.3724
Control variable						
Gender			-0.2020**	0.0861	-0.4391**	0.2129
Age			-0.1233***	0.0429	-0.3252***	0.1098
Educational background			0.0937**	.0366	0.2464***	0.0942
Position (with a reference to officials)						
2=Enterprise staff			0.1277*	0.0759	0.3650*	0.1925
3=None of the above			0.1534	0.0995	0.5086*	0.2798
Experience of migrant workers			0.2613***	0.0671	0.6759***	0.1826
Product brand			0.5080***	0.0828	1.2452***	0.2090
Provincial variable	Controlled		Controlled		Controlled	
Number of observations	612		612		612	
F value or Wald chi2(20)	10.65***		20.09***		246.64***	
R^2 or Pseudo R^2	0.0959***		0.3437		0.1661	

Note: ***, ** and * represent the significance level by 1%, 5% and 10%, respectively.

2. **Mediating effect.** From the benchmark model, we have identified the key factors influencing the online retail of agricultural products, but in fact the action mechanism of these factors still needs to be explored. In other word, it is about what channels or paths are used for internal and external factors to affect

the online retail of agricultural products. Thinking about this problem comes from experience and reality. A noteworthy phenomenon in reality is the emerging new media communication platform in recent years. Various new media communication means such as short video production and live commerce, including WeChat push, represented by Kuaishou and Douyin, have been so popular that they have become an important medium for online retail. Through such means, a growing number of operators are disseminating information about the production, processing and consumer experience of agricultural products in a visual and vivid way, thus attracting the attention of potential consumers and making for online orders. Therefore, inspired by Yang Guangqing et al.[34](2021), we used the mediation effect model to verify this.

The mediating variable is new media communication behavior. To put differently, it is whether an operator conducts new media communication activities leveraging the Internet, such as live streaming, video production, microblogging, and WeChat official account. As long as one or more of the activities are conducted, it is defined as having conducted new media communication activities (taking the value of 1). The proportion of the dependent variable online sales is a fixed-order variable, but the mediating effect needs to be handled according to multiple classification variables before it can be tested. The test procedure: first, take the online sales proportion of 0 as the base and do Logistic regression on the dependent variables with values of 2, 3, and 4 for the independent variable X and the mediating variable M, respectively; then obtain the values of regression coefficients and standard deviations for each group of models; and finally calculate and test them through the RMediation package in the R3.6.0 software. According to the findings, when the value of the dependent variable is 2, the confidence interval of whether to use new media communication means to mediate external environmental factors and the proportion (0-20%) of online sales of agricultural products is [0.2236, 1.4677], excluding 0, compared with the online sales proportion of 0. Therefore, the mediating effect is established. The mediating effect of new media communication on the relationship between external environment and e-commerce sales is significant. Similarly, when the dependent variable takes the values of 3 and 4, the corresponding confidence intervals are [0.3973, 2.4132] and [0.2858, 2.1229], respectively, neither of which contains 0, indicating that the mediating effect is established. The mediating effect of new media communication on the external environment and the network of agricultural products is significant. Table 6 is the estimation results of the mediating effect model. The results show that after controlling the characteristics of individual operators and products, the external environmental factors significantly affect an operator's new media communication activities. Finally, the new media communication will significantly impact the online retail of agricultural products. Therefore, the e-commerce industry of agricultural products could be developed by creating new media communication atmosphere and providing new media communication platform in order to foster internal and external factors to play a better role.

Table 6 Model of Mediating Effect of New Media Communication

Variable	Model (3) new media communication (M)		Model (4) online retail of agricultural products (Y)		Model (5) online retail of agricultural products (Y)	
External factors	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Industrial park	0.5818**	0.2475	0.6295***	0.2012	0.5030**	0.2065
Business environment	0.5214***	0.1208	0.2944***	0.0984	0.1678*	0.1019
Funding sources						
2=Financing loan	-0.1538	0.2827	-0.2032	0.2341	-0.2175	0.2362
3=Borrowing	-0.8031***	0.2981	-0.5754**	0.2692	-0.3961	0.2806
4=Other channels (government support and venture capital)	-0.2973	0.3025	-0.3293	0.2454	-0.3127	0.2566
Location	0.1145*	0.0673	0.0301	0.0236	0.0113	0.0232
Customer distribution						
2=Inside and outside China	0.4969**	0.2206	0.8068***	0.1845	0.7089***	0.1859
3=Intermediary purchase (unclear)	0.2844	0.5171	-0.7143*	0.3724	-0.7947**	0.3576
New media communication					1.4517***	0.2041
Other variables	Controlled		Controlled		Controlled	
Wald chi2(20)/Wald chi2(21)	143.06***		246.64***		286.28***	
Pseudo R^2	0.2488		0.1661		0.2036	
Number of observations	612		612		612	

Note: ***, ** and * represent the significance level by 1%, 5% and 10%, respectively.

5. Conclusion and Policy Implications

By using the sample data covering five provinces and one municipality directly under the central government, an empirical study was conducted on the factors affecting online retail of agricultural products from the perspective of government, market and new media technology. What the results show are as follows.

First, policy support, business environment, market and other external factors significantly affect the online retail of agricultural products under the condition of controlling the characteristics of individual operators and products. Specifically, operators located in industrial parks will see a significant increase in the proportion of their online sales of agricultural products. The better the business environment evaluation, operators will also have a significant increase in the proportion of online sales. Operators whose customers are distributed throughout and outside the country will see significantly higher online sales than those whose consumers are only within a province.

Second, the quality and ability of operators that reflect internal factors significantly affect the share of online retail of agricultural products. Specifically, rural male operators do not perform as well as female ones, suggesting that the penetration of new online media technologies in the countryside has created new spaces for empowerment and development of rural women. Consistent with existing studies, the older an operator, the lower the proportion of online retail. Both educational background and work experience have a significantly positive effect on the proportion of online retail. Therefore, it is obvious that the digital economy requires higher quality and ability of workers engaged in e-commerce, which is manifested in higher requirements for their educational background, awareness and vision, as well as youthfulness.

Third, the characteristics of a brand are a key determinant of online retail, with operators who have registered brands having significantly higher online sales than those without any brand. This point shows that whether in the traditional market space or the online retail space of digital economy, it is ultimately the products that determine the market. This is also supported by the estimations of the linear regression model, where the influence coefficient value of the product brand factor is 0.5080, much higher than the coefficient values of other variables.

Fourth, the mediating effect of new media communication on the relationship between the external environment and online retail of agricultural products is significant under the condition of controlling the characteristics of individual operators and products. This point indicates that internal and external factors significantly influence operators' new media communication activities and new media communication significantly affects the online retail of agricultural products. Therefore, the e-commerce industry of agricultural products could be developed by creating new media communication atmosphere and providing new media communication platform in order to foster internal and external factors to play a better role.

The No. 1 central document in 2021 proposed that e-commerce needs to be further developed in rural areas to sell agricultural products from villages to cities and facilitate the urban-rural connection between production and consumption. Based on the policy context, the policy implications of the above findings are as follows.

First of all, it is necessary to promote the development of regional e-commerce industry clusters in the context of comprehensive rural vitalization. Rural e-commerce has unique advantages in promoting the cross-integration of the primary, secondary and tertiary industries in rural areas thanks to the digital economy. However, there is also an imbalance in the development of rural e-commerce. For one thing, in the developed eastern provinces represented by Zhejiang and Jiangsu, the rural e-commerce has been developed as industrial clusters. However, in the central and western regions, rural e-commerce is booming but lack of industrial clusters and agglomeration effects. Another aspect is that the rural e-commerce industry chain is imbalanced. Processing, warehousing, logistics and sales have not formed an effective industry-wide chain and industrial alliances, each operating on its own. Accordingly, in terms of policy support for the rural e-commerce industry, it is necessary to create region-wide e-commerce

industry clusters, including industrial parks, warehousing & logistics parks and e-commerce industry parks across administrative regions. This is not only conducive to the benefits of industry clusters but also to the development of the regional economy.

Then, it is important to nurture new business entities of the industry chain, especially to strengthen the training about new media communication technology, operation and management. According to the research, the e-commerce industry requires higher ability and quality of workers than the traditional industry. In this new situation, it is important to pool and foster local young talents, such as rural start-up pioneers, returned start-up owners, and managerial talents of enterprises and cooperatives. By relying on the talent vitalization training system, the training on new media communication technology, operation and management needs to be held to better boost the development of rural e-commerce and the prosperity of rural industries.

Again, the brand and quality of agricultural products remain the key factors affecting the online retail of agricultural products, so there is still a need to strengthen the supply-side reform of agriculture or their brand building and quality enhancement. In the environment for online retail, it is still the brand and quality that win consumers. As such, it is essential to raise the brand awareness of agricultural products among e-commerce operators. For one thing, the government can provide support for operators in applying and registering agricultural brands; for another, it also needs to scale up the building and dissemination of regional agricultural brands.

Finally, a more favorable external environment needs to be created for the development of rural e-commerce. National policies and measures for rural e-commerce cover digital infrastructure, logistics system and technical support. However, local business environment, financing environment and other service factors are also important for small and micro e-commerce enterprises in less developed areas. With the further development of the Internet economy, it is also an effective means to boost the development of rural e-commerce by enhancing the quality of market services and improving the business environment and financing environment.

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