# Digital Empowerment: Unravelling the Mechanism of Rural E-Commerce on Entrepreneurship and Income Growth

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## Abstract

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**Keywords:** rural e-commerce; farmers' income; farmers' entrepreneurship;"Internet + entrepreneur ship"

# 1 Introduction

In the era of digitalization, driven by the widespread adoption of the internet, China has entered a phase of significant transformation. This transition has provided opportunities for the emergence of novel product forms and business models, with the e-commerce paradigm standing out prominently. In comparison to traditional trade, e-commerce offers distinct advantages such as overcoming geographical limitations, reducing trade costs, streamlining distribution channels, and standardizing trade practices. In order to propel the development of e-commerce, the Ministry of Commerce in China introduced the "Internet + Commerce" Action Plan in 2015, with a particular emphasis on the growth of rural e-commerce.

Rural areas have long been a focal point of attention in China, and addressing the income disparities among rural residents has remained a key policy goal. The significance of this goal is accentuated, especially given the pronounced urban-rural income gap. In recent years, the government has introduced policies aimed at encouraging rural entrepreneurship. However, rural residents face multifaceted challenges when embarking on entrepreneurial endeavors, including a lack of entrepreneurial experience, inadequate financial support, and a dearth of suitable business opportunities. Against this backdrop, rural e-commerce has emerged as a promising and transformative force, prompting numerous regions to actively promote its development. China, with a substantial rural population, holds tremendous potential for rural e-commerce. Nevertheless, despite the rapid growth of rural e-commerce, there exist certain limitations in the existing body of research, necessitating a deeper and more comprehensive analysis.

The rapid rise of e-commerce is profoundly impacting the agricultural sector by enhancing the visibility of agricultural products, expanding sales channels for farmers, reducing transaction steps and costs, creating additional income opportunities, and fostering sustainable development in rural areas. Presently, there is a growing body of literature focusing on rural e-commerce. However, much of this research predominantly addresses surface-level aspects and lacks in-depth and meticulous analysis. In the broader context of the "Internet + Entrepreneurship," an investigation into the impact of rural e-commerce on farmers' income not only contributes to enriching and extending the current body of knowledge but also serves to bridge certain gaps in the existing research landscape. This study, therefore, seeks to address these research limitations by delving deeper into the influence of rural e-commerce on farmers' income and by providing a more comprehensive theoretical and empirical foundation for the development of rural e-commerce in China.

# 2 Conceptual Definition and Theoretical Foundation

## 2.1 Concepts related to rural e-commerce

### *2.1.1 Electronic commerce*

Currently, there exist multiple definitions for the concept of electronic commerce (e-commerce), with varying perspectives among scholars. Drawing upon an analysis of relevant research literature, this paper synthesizes these viewpoints and posits that e-commerce refers to commercial activities facilitated by network information technology for the supply, exchange, and sale of goods. In other words, it entails the provision and sale of goods and services over the Internet in a novel, paperless transaction format spanning local area networks, wide area networks, and metropolitan area networks. E-commerce represents a measure taken to enhance the efficiency of commercial activities by overcoming temporal and spatial constraints, building upon traditional business practices, and ushering in a new form of trade hinged on digital technology and online networks. As a burgeoning model of business operations, it holds substantial potential for development in both commodity trade and financial services.

### 2.1.2 Rural e-commerce

Presently, electronic commerce (e-commerce) in rural contexts is defined in various ways by scholars from different countries, each tailoring the definition to their specific research focus. In the majority of cases, scholars concur that rural e-commerce involves a series of commercial activities that leverage fast, efficient, and cost-effective network technology and internet-enabled electronic devices to promote, market, and sell agricultural products on the internet. This paper amalgamates relevant research findings and posits that rural e-commerce encompasses economic activities conducted on the internet, encompassing the production, marketing, promotion, and sale of agricultural products, as well as various life and business network services closely related to rural livelihoods. The development of rural e-commerce enables farmers to market and promote agricultural products on the internet, mitigating issues such as product unsold due to information asymmetry or price manipulation. It accelerates the flow of agricultural products, averting economic losses stemming from product stagnation, and contributes to maintaining product freshness.

## 2.2 Theoretical foundation

*2.2.1 Economies of Scale Theory*

Economies of Scale Theory, also referred to as Economies of Scope Theory, posits that as the scale of production expands, profitability increases. For instance, when producing goods that require the input of multiple production factors, doubling the quantity of all input factors can result in a more than twofold increase in product output, consequently leading to a reduction in average production costs per unit. This economic principle was first introduced by the renowned economist Adam Smith in "The Wealth of Nations," where he emphasized that specialization enhances the skills of individual workers and saves considerable time otherwise wasted due to job hopping. John Stuart Mill systematically analyzed the Economies of Scale Theory, highlighting how large-scale production can effectively reduce operational and distribution costs for businesses.

In the context of rural e-commerce, a pivotal aspect involves harnessing internet technology to consolidate diverse and dispersed resources, such as agricultural product information, user data, and enterprise data, to form an integrated value chain. This integration spans production, packaging, and logistics, facilitating centralized large-scale operations. Leveraging the foundation of Economies of Scale Theory, rural e-commerce stands to significantly reduce associated costs, thereby optimizing economic benefits.

*2.2.2 Industry Chain Theory*

The value chain is a derivative relationship that typically links related resources, products, and services within industrial clusters. This relationship encompasses various aspects, including product interconnections, supply relationships, value relationships, and more, exhibiting characteristics of comprehensiveness, directionality, and hierarchy. Furthermore, the value chain can be divided into four dimensions: the supply chain, the enterprise chain, the value chain, and the spatial chain. When the interactions between these dimensions are balanced, a relatively stable value chain with self-regulatory capabilities is formed, and the generation of added value within this chain constitutes its core.

The agricultural value chain, as a specific subset of the value chain, primarily revolves around agricultural products and typically constitutes a network structure closely associated with primary agricultural production. Within the process of product circulation, efficient connections among various links play a pivotal role in ensuring the smooth operation of the rural e-commerce value chain.

*2.2.3 Internet Marketing Theory*

A novel marketing paradigm currently in use is internet marketing. Specifically, it is a marketing approach that utilizes online media and information technology to achieve marketing objectives, based on an interactive mode of marketing. The distinctive features of this form of marketing include transactions typically being conducted online, a more efficient and convenient marketing process, and significantly reduced marketing costs. Presently, the primary methods employed include platform marketing, website advertising, software promotion, search engine marketing, among others. Website advertising and software promotion have a broader target audience reach, in contrast to search engine pay-per-click advertising, which often only targets specific customer groups. However, advertising costs on some highly visible websites or software platforms are generally high, which may pose challenges for typical rural e-commerce entities as they struggle to cover advertising expenses. Consequently, precise evaluation of advertising effectiveness and cost control become essential. Currently, in the development of rural e-commerce, the applications of e-commerce platform marketing, B2B platform marketing, and search engine marketing are relatively more widespread.

# 3 Current Status of Rural E-Commerce Development in China

## 3.1 The Policy Environment for Rural E-commerce in China

The policy environment for rural e-commerce in China has evolved significantly in the policy Environment for Rural E-commerce in China has evolved significantly recent years, creating a conducive atmosphere for its development. First, in 2005, the State Council issued a directive titled “Several Opinions on Accelerating the Development of E-commerce”, marking China’s first comprehensive policy document promoting e-commerce. Later, the State Council General Office released the “Opinions on Accelerating the Transformation of Agricultural” in 2015. This policy urged transparency in transactions to eliminate barriers between consumers and participants in rural e-commerce. It introduced the concept of “innovative agricultural marketing services”, encouraging collaboration between various agricultural operators and e-commerce enterprises. The goal was to cultivate new formats for agricultural product distribution and promote the development of logistics and distribution facilities. Subsequently, in October of 2017, the State Council issued the “Guiding Opinions on Accelerating the Development of Rural E-commerce”. This directive actively encouraged the growth of rural e-commerce. To ensure the safe conduct of rural e-commerce for operators and consumers alike, it required relevant local authorities to establish legal frameworks and mechanisms for resolving disputes related to rural e-commerce. It also advocated the incorporation of modern management concepts and methods, such as industrial chains, supply chains, and value chains, into agriculture. The goal was to establish, by early 2020, a rural e-commerce market system characterized by integrity, compliance, orderly competition, and environmental sustainability. All the above policies released by government have collectively fostered a favorable policy environment for rural e-commerce, facilitating its growth and development.

## 3.2 The Foundational Conditions of Rural E-commerce in China

*3.2.1 Hardware Conditions of Network Infrastructure*

China’s network information technology and related infrastructure construction have developed rapidly since entering the 21st century. With the support of national finances and technology, significant progress has been made in the construction of rural information networks in China. The goals of rural network coverage have been achieved ahead of schedule, with a fiber optic penetration rate reaching 98%. During the 12th Five-Year Plan period, China achieved full coverage of e-commerce in rural areas, including all impoverished counties. A significant number of comprehensive agricultural information service platforms and demonstration bases were established, providing crucial support to rural areas. Simultaneously, the “Internet

+ Wisdom Assistance" project has also achieved remarkable results. The internet access rate in rural primary and secondary schools nationwide increased from 78.3% at the end of 2015 to 98.7% at the end of 2020. This has provided a talent reserve for the future development of rural e-commerce and laid an important foundation for the development of rural e-commerce in the context of "Internet + Entrepreneurship".

3.2.2 Market Conditions with Abundant Agricultural Product Supply

Rural development in China has been rapid, with the country leading the world in the production of meat, poultry, eggs, and aquatic products. Grain production has also seen fourteen consecutive years of growth. Rural areas boast a rich variety of agricultural and sideline products, some of which are highly popular with consumers both domestically and internationally. Table 1 illustrates the changes in the output value of China's agriculture, forestry, animal husbandry, and fishery sectors from 2018 to 2023. It is evident that the total output value of each industry has maintained continuous growth, driven by the robust supply and demand in the agricultural product market. This growth has facilitated the rapid expansion of China's rural e-commerce market and stimulated the demand for agricultural market information. Furthermore, in the era of "Internet+", the traffic to major agricultural information websites in China continues to rise. Currently, these websites rank among the top three global rural e-commerce platforms, laying a solid foundation for the development of China's rural e-commerce market.

*3.2.3 Mature and Convenient Electronic Payment Means*

China's rural electronic payment market has been experiencing rapid development, with an average annual growth rate of over 20% in recent years. In rural areas, electronic payment channels have evolved from basic online banking payments to include various coexisting methods such as phone payments, mobile payments, online payments, and third-party payments. These multiple payment options cater to the diverse needs of different users engaged in rural e-commerce. Furthermore, China has established a basic payment clearing system among commercial banks. As of the end of 2020, the People's Bank of China had issued payment business licenses to 147 third-party payment institutions. In addition, in recent years, many market entities such as portal websites, publicly listed companies, and e-commerce platforms have actively entered the field of internet payments. They have done so by establishing, investing in, or acquiring payment companies, providing a flexible and diverse range of financial platforms to support the development of rural e-commerce.

Table 1: China's agriculture, forestry, pastoralism and fishery output value statistics(billion yuan)

| Year | Agriculture | Forestry | Pastoralism | Fisheries | Agriculture, forestry and fisheries services |
|---|---|---|---|---|---|
| 2018 | 64865.92 | 5681.78 | 36329.01 | 12382.25 | 4869.90 |
| 2019 | 71897.26 | 7646.88 | 45508.51 | 14544.12 | 5585.42 |
| 2020 | 18676 107 | 8798.13 | 47028.57 | 16146.23 | 6173.81 |
| 2021 | 84137.11 | 9789.09 | 49197.15 | 18440.78 | 6811.43 |
| 2022 | 89006.64 | 11889.09 | 49647.07 | 19307.44 | 7546.38 |
| 2023 | 91316.67 | 12184.44 | 52877.22 | 19953.02 | 8065.28 |

Data source: National Statistical Yearbook

*3.2.4 Quality Warehousing and Logistics Services*

The improvement of supporting services such as warehousing and logistics is currently bridging the last mile of rural e-commerce development in China. In the 13th Five-Year Development Plan of China, there is a clear goal to achieve basic access to courier services in every village by the year 2020. This target has created favorable conditions for the development of rural e-commerce. Moreover, e-commerce giants like Alibaba, JD.com, and Suning have actively established their own logistics and distribution systems in rural areas to capture more business opportunities. Alibaba, leveraging Cainiao Network and other third-party logistics companies, has facilitated package delivery. JD.com and Suning, on the other hand, have set up their own warehouses at the county and even village levels, establishing efficient channels of communication between suppliers and farmers in rural e-commerce. Additionally, various major express delivery companies have accelerated their entry into rural markets, establishing comprehensive logistics and distribution networks. These efforts have played a positive role in the development of rural logistics and distribution, greatly promoting the growth of rural e-commerce.

## 3.3 Major Problems in the Development of Rural E-Commerce in China

*3.3.1 Insufficient development of market players*

China's rural agricultural population is substantial, and many farmers have relatively limited education, leading to lower levels of science and technology expertise and cultural awareness. They possess limited knowledge of information technology and are more inclined towards traditional methods of production and lifestyle. Furthermore, the majority of farmers are unfamiliar with computers and e-commerce operations, resulting in a lack of awareness and limited organizational skills, which significantly hinders the rapid development of rural e-commerce. Additionally, the underdeveloped economic and social conditions and cultural environment in rural areas, coupled with the lengthy and challenging nature of agricultural technology training, deter many individuals with knowledge of e-commerce technology and management from showing a strong willingness to work in rural areas. Even those who do go often find it difficult to remain. This severe shortage of rural e-commerce talent does not support the rapid and stable growth of rural e-commerce.

*3.3.2 Infrastructure Development Lags Behind*

In some rural areas, network communication infrastructure is weak, information technology equipment is outdated, and the hardware and software conditions for network security are insufficient to meet the requirements of e-commerce development. Additionally, logistics and distribution mainly involve road construction, information transmission, product processing, transportation, warehousing, and cargo management. However, organic green agricultural products are often produced in remote rural or hilly areas where many roads have poor quality, transportation options are limited, and the extended transport times due to remote locations make it even more challenging to ensure the freshness of agricultural products. The relatively underdeveloped logistics infrastructure in rural areas also hinders the rapid development of rural e-commerce.

*3.3.3 Inadequate Service Application Capability*

Currently, there are over 2,000 rural e-commerce websites in China, but most of them lack professional standards and distinctive features. These websites have long update cycles, a high degree of content repetition, and provide more information to leaders than to farmers. They lack practicality, targeted services, and have insufficient service application capability. Additionally, due to the differences and complexities in factors like regional geography, resources, climate in agricultural production, and the long-term accumulation of big data related to rural human society, natural environment, and economic conditions, the accumulation of big data related to rural areas in China is relatively weak, making it challenging to establish large-scale practical databases.

*3.3.4 Low Standardization Level of Agricultural Products*

China's agricultural production has a low overall level of standardization and is characterized by small-scale, relatively dispersed, diverse, and low-value-added production. Agricultural products undergo a lengthy process from fields to tables, involving planting, harvesting, processing, packaging, transportation, and sales, among other intermediate steps. However, the information symmetry in China's rural product transactions is poor, and there is significant fragmentation in the supply chain. E-commerce is best suited for standardized, recognizable, and market-accepted products. Yet, some non-standardized agricultural products lack reliable quality and safety assurances, making them challenging to be accepted by consumers, businesses, and the market, thereby hindering their sales.

# 4 Current Situation of Chinese Farmers' Income

## 4.1 Disposable Income of Chinese Farmers

In the Initial Central Document in 2013, the Chinese government pointed out that China's agriculture faced prominent contradictions in supply and demand, with comprehensive production costs continuously rising, leading to increasingly severe ecological degradation in rural areas. Issues such as farmers' diversification of income sources and rural depopulation became more pronounced. To address these challenges, China introduced a strategy for rural revitalization, promoting farmers' income growth, improving their quality of life, and tackling various problems in the agricultural development process, particularly through measures like the integration of the three rural sectors.

As shown in Figure 1, with the government's increased focus on agriculture and financial support, the per capita disposable annual income of rural residents in China has steadily increased from 4,144 yuan in 2011 to 15,192 yuan in 2023, nearly quadrupling during this period. These efforts have yielded significant results in increasing farmers' income.

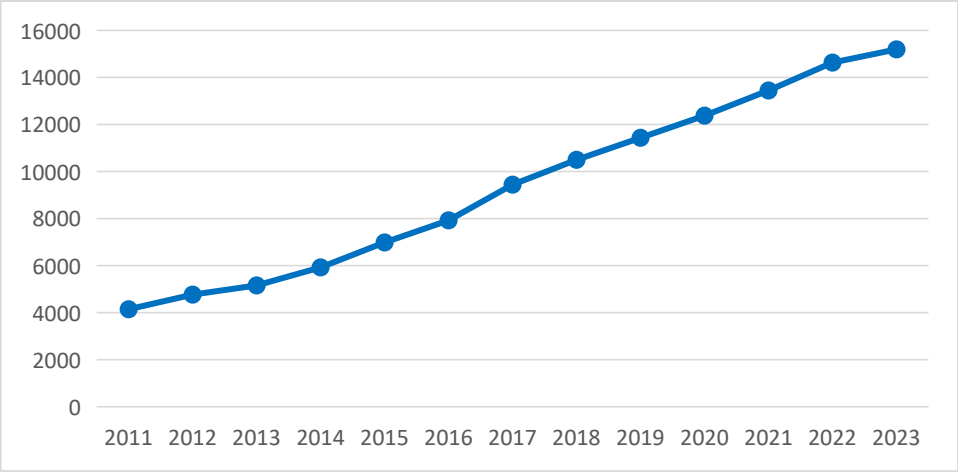


Figure 1: Changes of annual income of rural residents in China (per capita)

## 4.2 Analysis of the Structure of Chinese Farmers' Income

Farmers' annual income is primarily composed of four parts: wage income, household business income, property income, and transfer income, as shown in Table 2. Additionally, the bar chart Figure 2 displays the structure and proportion of the annual income sources for farmers in per capita.

From the two graphs, it can be observed that wage income and household business income consistently constitute the majority of farmers' income sources. With the development of urbanization and the advancement of measures to support rural migrant workers, farmers have increasingly found employment opportu-

nities in various positions, leading to a significant increase in wage income, rising from 1,598 yuan in 2011 to 6,208 yuan in 2023. While household business income also has a substantial share, its proportion has been gradually decreasing overall. This shift is attributed to farmers diversifying their sources of income, no longer solely relying on agricultural production. Farmers' property income showed slow and continuous growth from 2011 to 2023, but its proportion remained small and demonstrated a decreasing trend. This indicates that rural residents have relatively low financial awareness and investment levels, making it challenging for them to utilize their assets to generate additional wealth. Farmers' transfer income increased nearly 14-fold from 222 yuan in 2007 to 3,190 yuan in 2023. This growth can be attributed to the critical period of "comprehensive prosperity" during this timeframe. The government increased investment and support for rural areas, enhancing fiscal transfers, thereby gradually raising farmers' transfer income.

Table 2: Composition of Chinese farmers' annual income

| Year | Annual income (per capita) | Salary income | Household business income | Property income | Transfer income |
|---|---|---|---|---|---|
| 2011 | 4144 | 1598 | 2196 | 128 | 222 |
| 2012 | 4766 | 1856 | 2438 | 148 | 324 |
| 2013 | 5157 | 2063 | 2529 | 167 | 398 |
| 2014 | 5924 | 2433 | 2836 | 202 | 453 |
| 2015 | 6984 | 2966 | 3225 | 229 | 564 |
| 2016 | 7924 | 3451 | 3537 | 249 | 687 |
| 2017 | 9441 | 3657 | 3939 | 195 | 1650 |
| 2018 | 10498 | 4156 | 4241 | 222 | 1879 |
| 2019 | 11434 | 4605 | 4509 | 252 | 2068 |
| 2020 | 12375 | 5027 | 4746 | 272 | 2330 |
| 2021 | 13445 | 5503 | 5033 | 303 | 2606 |
| 2022 | 14631 | 6002 | 5364 | 342 | 2923 |
| 2023 | 15192 | 6208 | 5437 | 357 | 3190 |

Data source: National Statistical Yearbook and Avery Consulting

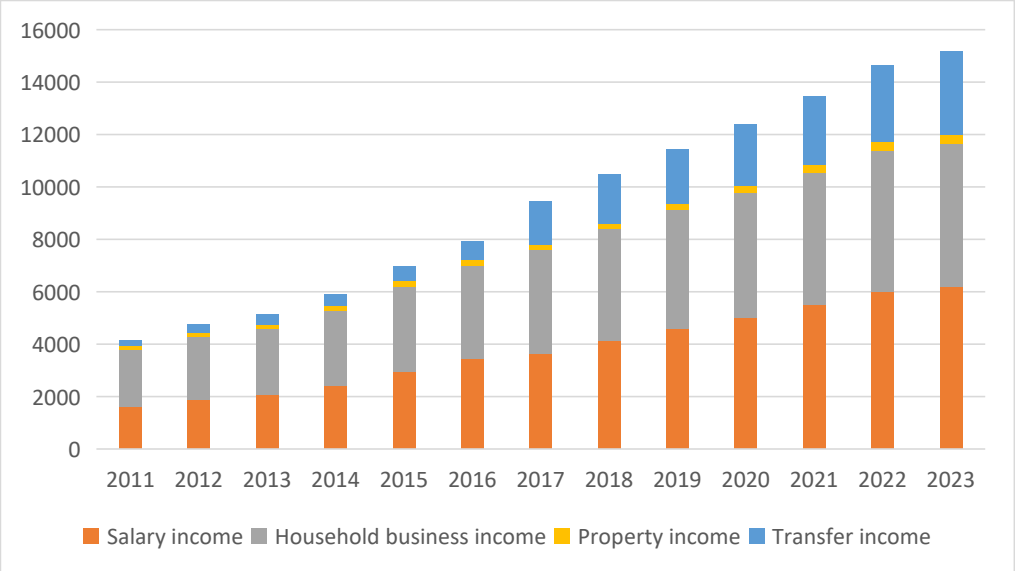


Figure 2: Structure and proportion of Chinese farmers' income source

### 4.3 Income Disparity Between Urban and Rural Residents in China

As shown in Figure 3, the per capita income of urban residents significantly surpasses that of rural residents in the decade. Although there is an obvious decline during 2013-2017, the per capita income of urban residents has been increasing vigorously from 2013, leading to a widening income gap between urban and rural areas. In terms of per capita income and overall consumption in rural areas, farmers' consumption accounts for approximately 80% of their income. Most of their income is allocated to the consumption of production materials and the purchase of essential goods. Faced with natural disasters or major illnesses, their limited remaining assets can result in significant financial shortfalls.

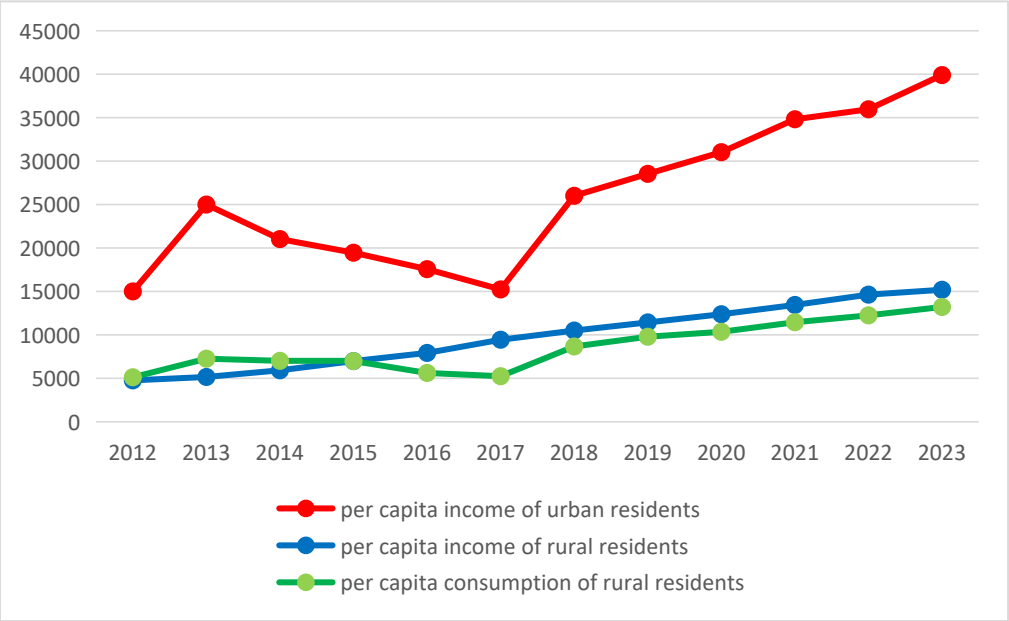


Figure 3: Comparison of income and consumption between urban and rural areas

## 5 Empirical Analysis

### 5.1 Sample Selection and Data Sources

This chapter is to explore the relationship between rural e-commerce, farmer entrepreneurship, and farmer income growth. Combining with the research models of relevant scholars, the main variables selected for empirical research are as follows:

Dependent Variable: Farmer Income (y). The per capita disposable income of rural households, formulated by the National Bureau of Statistics, is a scientific indicator to measure the income level of farmers. Therefore, this study chooses the per capita disposable income of rural households as the dependent variable for research.

Independent Variable: The purpose of this chapter is to explore the impact of rural e-commerce and farmer entrepreneurship on farmer income. Therefore, this study selects rural e-commerce (eco) as the independent variable for analysis. Since rural e-commerce in China is still in the development stage and has not formed a unified database, it is difficult to obtain precise data on the level of rural e-commerce development. Rural express delivery services are a crucial and core component of rural e-commerce. Hence, this study uses the volume of rural express delivery services to measure the level of rural e-commerce development.

Control Variables: As the main factors affecting farmer income, this study selects farmer entrepreneurship, the extent of financial support for agriculture from the government, rural grain production, and rural education level as control variables.

(1) Grain Production (crop): For farmers currently engaged in agricultural production, grain is their main source of income. Grain production reflects the effectiveness of farmers' production. The higher the grain production, the more income farmers will earn. In this study, grain production is measured based on the ratio of the area of grain cultivation to total grain production in rural areas.

(2) Financial Support for Agriculture (exp): The extent of financial support for agriculture from the government has a significant impact on the daily lives and production activities of farmers. The larger the amount of financial support for agriculture, the higher the income of farmers. In this study, the extent of financial support for agriculture is measured based on the annual amount of financial support for agriculture by the government.

(3) Rural Education Level (edu): Many scholars have found that increasing investment in human capital in rural areas can also promote income growth for farmers. In rural areas, investment in human capital can be considered as the education level of farmers. In this study, the education level of farmers is based on the number of people with a high school education or above in rural areas.

(4) Farmer Entrepreneurship (employ): The main forms of farmer entrepreneurship in China are individual businesses and the establishment of private enterprises. Accurate data on farmer entrepreneurship in China is difficult to collect. Considering data availability, this study measures farmer entrepreneurship by the number of individual business operators in rural areas and the proportion of private enterprise investors to the total rural population.

Based on the availability of data, this study utilizes panel data from 29 provinces and municipalities in China for the years 2011-2023. Please note that Tibet and Xinjiang were not included in the analysis due to missing data. The empirical research is conducted using EViews. The data sources for this study include the "China Rural Statistical Yearbook," provincial statistical yearbooks, and sources from Alibaba Research Institute, among others. Considering the impact of the Consumer Price Index (CPI), this study uses 2015 as the starting point to adjust the per capita net income of rural residents using the rural consumer price index. Additionally, due to the large amount of collected data and to ensure the stability of the results, logarithmic transformations were applied to these variables. The definitions and indicators of the main variables for empirical research are shown in Table 3.

Table 3: Variables and Definitions

| Variable | Name | Measurement Indicator | Symbol |
|---|---|---|---|
| Dependent Variable | Farmer Income | Per Capita Net Household Income | y |
| Independent Variable | Rural E-commerce | Express Delivery Service Volume | eco |
| Control Variables | Grain Production | Total Grain Production / Cultivated Area | crop |
| | Government Financial Support for Agriculture | Financial Support for Agriculture Amount | exp |
| | Rural Education Level | Number of People with High School Education or Above | edu |
| | Farmer Entrepreneurship | (Number of Individual Business Operators + Number of Private Enterprise Investors) / Total Rural Population | employ |

## 5.2 Empirical model setting

$$ln\, y_{i,t} = \alpha_0 + \alpha_1 ln\, eco_{i,t} + \alpha_2\, crop_{i,t} + \alpha_3 ln\, exp_{i,t} + \alpha_4 ln\, edu_{i,t} + \alpha_5\, employ_{i,t} + v_i + \varepsilon_{i,t} \quad (1)$$

In model (1), the natural logarithm of for rural e-commerce is used as the explanatory variable, and the natural logarithm of for rural household income is used as the dependent variable, while other variables are used as control variables.

## 5.3 Panel Data Unit Root and Cointegration Tests

In order to avoid spurious regression and ensure the validity of measurement results, this paper conducted unit root tests for the panel data's stationarity. The examination results in Table 4 indicate that, except for the crop variable, which shows stationarity in all tested methods for level sequences, the level sequences of other variables are not stationary in all tests. However, all variables exhibit stationarity in their first-order differenced sequences at a 5% significance level, making them all first-order integrated.

Next, a cointegration test is conducted to study the equilibrium relationship between rural e-commerce, farmers' entrepreneurship, and farmers' income. As shown in Table 5, it can be observed that at a 1% significance level, the null hypothesis is rejected, indicating the existence of a long-term equilibrium relationship between the variables, allowing for regression analysis.

Table 4:Unit Root Test Results for Panel Data

| Variable | LLC | IPS | ADF | PP |
|---|---|---|---|---|
| *lny* | 11.1465 | 9.4581 | 7.7991 | 12.2237 |
| | -1.0300 | -1.0300 | -1.0300 | -1.0300 |
| lneco | -4.8195 | 1.6402 | 43.5291 | 87.4849 |
| | 0.0000 | -0.9386 | -0.9402 | -0.0078 |
| lnexp | 13.1716 | 7.7286 | 21.5800 | 22.5875 |
| | -1.0300 | -1.0300 | -1.0300 | -1.0300 |
| crop | -14.4561 | -1.9046 | 91.6931 | 185.7760 |
| | 0.0000 | -0.0332 | -0.0034 | 0.0000 |
| lnedu | 1499.6800 | 3.3385 | 21.7900 | 20.9258 |
| | -0.7629 | -1.0294 | -1.0300 | -1.0300 |
| employ | -23.2182 | -6.2886 | 138.8358 | 226.5804 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| △ lny | -0.1052 | -1.8732 | 97.0108 | 94.6928 |
| | -0.3090 | -0.0355 | -0.0011 | -0.0019 |
| △ lneco | -35.3423 | -6.7180 | 138.2260 | 189.2110 |
| | -0.3090 | 0.0000 | 0.0000 | 0.0000 |
| △ lnexp | -3.5098 | -1.0499 | 80.3067 | 107.3600 |
| | -0.3090 | -0.0453 | -0.0286 | -0.0001 |
| △ crop | -12.6666 | -4.2812 | 117.1017 | 153.7584 |
| | -0.3090 | 0.0000 | 0.0000 | 0.0000 |
| △ lnedu | -16.1342 | -4.4493 | 120 9 24 | 158.2008 |
| | -0.3090 | 0.0000 | 0.0000 | 0.0000 |
| △ employ | -133.2758 | -19.1790 | -150.8198 | 193.4113 |
| | -0.3090 | 0.0000 | 0.0000 | 0.0000 |

Table 5: Cointegration test results for panel data

| Test Method | Statistic Object | Statistic Value | P-Value |
|---|---|---|---|
| Pedroni test | V-Statistic | -2.8633 | 0.0000 |
| | Rho-Statistic | 4.7635 | 0.0071 |
| | PP-Statistic | -8.1464 | 0.0000 |
| | ADF-Statistic | -3.3845 | 0.0000 |
| Kao test | ADF | -4.3849 | 0.0002 |

## 5.4 Empirical Results and Analysis of the Econometric Model

After passing the data tests, we progressively incorporated each variable into the fixed-effects regression model for analysis. The results are presented in Table 6. From the table below, we can observe that when all variables are included, rural e-commerce development exhibits a positive and statistically significant relationship with rural income at the 5% significance level. This indicates that rural e-commerce can directly promote an increase in rural income.

Table 6: Fixed Effects Regression Results

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| lneco | 0.3314*** | 0.2826*** | 0.3106** | 0.4454* | 0.4167** |
| | (4.23) | (4.15) | (2.23) | (1.47) | (2.25) |
| lnexp | | 0.2246 | 0.2257 | -0.0138 | 0.2908*** |
| | | (1.72) | (1.56) | (-0.11) | (5.34) |
| crop | | | 0.1833 | 0.1964 | 0.1168 |
| | | | (0.29) | (0.68) | (-0.40) |
| lnedu | | | | 4.3562*** | 2.2173*** |
| | | | | (1.95) | (1.53) |
| employ | | | | | 1.1329*** |
| | | | | | (2.84) |
| _cons | 8.8036*** | 8.6393*** | 8.5498*** | 7.2202*** | -8.9134*** |
| | (405.54) | (85.63) | (25.97) | (22.16) | (-5.86) |
| N | 253 | 253 | 253 | 253 | 253 |
| $R^2$ | 0.0253 | 0.0354 | 0.0397 | 0.2638 | 0.6985 |

Note: ***, **, and * represent significance at the 1%, 5%, and 10% levels respectively, the same below.

As for the control variables, the impact of financial support for agriculture (exp) on rural income is not statistically significant. This suggests that the financial allocations made by the national government for rural areas have limited effects on increasing rural incomes. Despite improvements in the conditions of various impoverished rural regions and a significant reduction in the number of people living in poverty following the implementation of rural support policies, a considerable portion of rural poverty alleviation funds have been directed towards the construction of impressive but often superficial projects. By the time these funds reach the hands of rural residents, they are often in short supply, leaving the economic circumstances of some farmers unchanged.

Rural residents' incomes remain relatively low compared to their urban counterparts. While an increase in grain production (crop) positively contributes to higher rural incomes, its impact is less significant compared to education and entrepreneurship. This may be attributed to the diversification of employment op-

portunities for rural residents in recent years, with more individuals engaging in non-agricultural activities. Consequently, the reliance on grain production for income augmentation has diminished, reducing the influence of grain production on rural incomes.

Rural education level (edu) demonstrates a significant positive effect on rural incomes at the 1% significance level. This indicates that higher levels of education among rural residents lead to increased income levels. As illustrated in the accompanying figure, a significant correlation between rural residents' education levels and income levels isevident. This is because higher educational attainment equips individuals with stronger innovative abilities, and innovation is a source of sustained development. Therefore, as the level of education among rural residents rises, so do their income levels.

Rural entrepreneurship (employ) exhibits a significant positive impact on rural income at the 1% significance level. This underscores the role of rural entrepreneurship in facilitating income growth for rural residents. The entrepreneurial endeavors of rural residents enhance their work motivation, boost the economic vitality of rural areas, and effectively contribute to the elevation of income levels. It also stimulates the development of rural economies. Thus, rural entrepreneurship plays a substantial role in fostering income growth among rural residents. As a form of innovative behavior, a higher entrepreneurial spirit in rural areas generally corresponds to higher income levels.

In summary, rural e-commerce, education level, and entrepreneurship have significant positive impacts on rural income growth. Financial support for agriculture and crop production also has positive effects but to a lesser extent. This analysis demonstrates the importance of these factors in promoting rural income growth and rural economic development.

### 5.5 Robustness Tests

Since the variables described in this paper are dynamic, there may be endogeneity issues among the variables, which could lead to some bias in the research results. To avoid this situation and ensure the robustness of the model estimation results, this paper will further conduct robustness tests on the model. This paper draws on established testing models and conducts regression analysis of the explanatory variables of the model with a one-period lag, as shown in Table 7 for specific details. The results of the robustness tests indicate that the signs and magnitudes of the coefficients for each variable are generally consistent with the previous test results. This validates the robustness of the model and confirms the reliability of the research findings presented earlier.

## 6 DISCUSSIONS

According to the empirical analysis, there is a positive correlation between the development of rural e-commerce and farmers' income. This means the significant role of the e-commerce model in promoting farmers' income in China. Furthermore, the development of e-commerce has also stimulated the innovative potential of farmers and motivating them to engage in entrepreneurship. Therefore, the e-commerce model not only provides a pathway for farmers to increase their income but also offers them broader career development prospects, contributing to the sustainable development of rural areas.

However, despite the significant progress made by rural e-commerce in promoting rural entrepreneurship and farmers' income, there are still some shortcomings. Firstly, the network infrastructure and information technology equipment in some rural areas lag behind, limiting the development of e-commerce and farmers' participation. Secondly, a proportion of farmers may lack sufficient e-commerce awareness and skills, requiring more training and support. Additionally, the standardization level of agricultural products is relatively low, making it challenging to sell non-standardized agricultural products on e-commerce platforms, which restricts farmers' sales choices. Finally, the logistics and distribution systems in some rural areas are still not well-developed, resulting in higher costs for the preservation and transportation of agricultural products. Therefore, we propose the following recommendations for the development of rural e-commerce in China under the "Internet + Entrepreneurship" framework.

Firstly, increase government investment in rural network infrastructure. A well-developed network infrastructure is fundamental for the advancement of rural e-commerce in the context of "Internet + Entrepreneurship". Therefore, it is imperative to boost investments in rural network infrastructure construction and the planning of network website systems. Local governments should promptly introduce supportive policies and measures, fulfilling their role in macroeconomic regulation. They should guide rural residents in acquiring network technology skills while increasing local fiscal revenue. Additionally, incentive policies, such as subsidies for infrastructure and supporting equipment, can be implemented to encourage small businesses to expand their e-commerce operations. This will help farmers perceive a supportive policy environment, fostering their enthusiasm for rural e-commerce entrepreneurship and providing additional avenues for increasing their income.

Secondly, enhance awareness of e-commerce among rural residents. The traditional production and operation methods of farmers often exhibit a relatively closed nature. Cultivating awareness of rural e-commerce requires a shift in farmers' traditional mindsets. They should gradually embrace the concepts associated with "Internet + Entrepreneurship", acquire network technology skills, understand advanced agricultural production techniques and market information, and apply their knowledge of information technology to e-commerce or entrepreneurial activities. In the era of "Internet + Entrepreneurship", the government should actively promote the convenience of online transactions. They should guide farmers to experience online transaction processes firsthand and educate them on online transaction security. Enabling farmers to purchase suitable products at affordable prices in a secure and convenient manner will stimulate their e-commerce awareness. This, in turn, encourages farmers to leverage various advanced technologies for agricultural production, sales, or entrepreneurship, ultimately promoting rural e-commerce development in China and increasing farmers' income.

Thirdly, strengthen standardization and branding of agricultural products. Rural e-commerce is not solely about price competition; it also involves brand competition. Under the "enterprise-led, government-guided" principle, rural governments should facilitate geographical indication registration and certification, as well as trademark registration for organic and green foods tailored to local conditions. They should develop and nurture high-quality characteristic agricultural products, ensuring that these products are sold based on credibility and quality. In the era of "Internet + Entrepreneurship", where product information spreads rapidly, and considering the diversity of agricultural production methods and product types, China should establish standards that align with its national conditions. This will ensure the quality of agricultural products and services, enhance the market competitiveness of these products, increase the added value of goods, and improve the success rate of entrepreneurship. These efforts will contribute to the growth of farmers' income and enhance the competitiveness of rural e-commerce.

Finally, promote the establishment of a modern rural e-commerce logistics system. On the one hand, enhance basic transportation infrastructure for agricultural products. To foster rural e-commerce development and promote farmers' entrepreneurship and income in the "Internet + Entrepreneurship" era, a robust logistics distribution system is essential. Without it, e-commerce activities cannot be effectively executed. Firstly, by considering the current state of rural logistics, the focus should be on promoting and publicizing agricultural products, establishing a robust market system. Furthermore, specialized warehousing equipment for trade logistics should undergo large-scale, intensive integration and transformation to expand the logistics system further. Additionally, the construction of a modern logistics system should be accelerated, emphasizing areas such as processing, packaging, transportation, warehousing, and distribution. Special attention should be given to logistics distribution centers, logistics hubs, and transportation infrastructure. These efforts will facilitate the professional development of the logistics industry. On the other hand, promote the diversified development of third-party logistics entities. In the context of "Internet + Entrepreneurship", rural e-commerce is experiencing rapid growth. Ensuring the freshness and safety of agricultural products is crucial, but traditional agricultural product logistics often involve blind circulation of products, outdated disease and pest prevention methods, inadequate low-temperature treatment, and insufficient processing ca-

pabilities. The third-party logistics model, with logistics agencies at its core, offers an efficient solution. Under this model, logistics companies and agricultural product trading entities operate independently, enabling modern logistics distribution, professional services, information management, and centralized coordination. This significantly reduces logistics costs while expediting the product flow. Consequently, it is imperative to provide robust support for the development of third-party logistics companies through policies such as tax reductions and preferential interest rates on loans.

## 7 Conclusion

This study explores the application of e-commerce models in rural areas and finds a positive correlation between the advancement of rural e-commerce, farmer engagement in entrepreneurship, and increased income. However, there are deficiencies in China's rural e-commerce development, including network infrastructure, farmers' e-commerce skills, agricultural product standardization, and logistics. To address these issues, we provide targeted recommendations. These suggestions, based on China's experience, can serve as a reference for other countries, particularly developing ones.

This study still has some limitations. Firstly, the content analysis is limited to the Chinese case, which may restrict the generalizability of the findings. Further research could extend the empirical analysis of the impact of the e-commerce model on farmers' well-being to other countries and regions, especially in developing countries with a large proportion of rural residents. This research could reveal the particularly crucial role of e-commerce in rural development, especially in the context of the global public health crisis.

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