

Study on the effect of county e-commerce development on rural residents' income growth

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ABSTRACT

Against the background of rural revitalization and the development of county-level e-commerce industry, based on the data of Caoxian County of Heze, Shandong Province from 2017 to 2021, this paper studies the promotion effect of county-level e-commerce industry development on urban and rural residents' income through grey relative correlation analysis. The results show that the impact of the development of county e-commerce industry on the operational income of urban and rural residents is similar, and the impact on the operational income of rural residents is partly greater than that of urban residents, and the effect is not obvious. The influence of the development of county e-commerce industry on the wage income of rural residents is greater than that on the wage income of urban residents.

KEYWORDS

Income of urban and rural residents; E-commerce industry; Grey correlation.

1. INTRODUCTION

The development of rural industries can provide economic impetus for rural revitalization and improve the income level of rural residents. E-commerce industry has played an important role in the development of rural agricultural products industry, opening up the "main artery" of rural planting industry and domestic and foreign markets, expanding the sales channels of agricultural products, and providing a new entrepreneurial platform and income channels for rural residents. In recent years, the development of e-commerce industry has played an irreplaceable role in poverty alleviation. In the rural revitalization stage, the continued implementation of the "e-commerce poverty alleviation project" and "E-commerce into rural comprehensive demonstration work" is conducive to the effective connection between poverty alleviation achievements and rural revitalization [1]. As the continuation of poverty alleviation, rural revitalization has put forward higher requirements for the development of rural economy on the basis of building a moderately prosperous society in an all-round way.

County is a common scale to carry out research on urban and rural development. County is an important link between rural and urban areas, and is the focus of urban and rural development. County economy is the general term of economic relations and economic activities within the county [2]. The rapid development of county economy can speed up the process of rural revitalization and promote common prosperity [3]. The development of e-commerce industry has played an important role in improving the disposable income of rural and urban residents in Caoxian County, and is conducive to narrowing the gap between wage income and operational income of urban and rural residents. Electronic commerce is a new form of network economy, which changes the transaction mode of

consumers and merchants. This paper takes Caoxian County of Heze as the research object to study the relationship between the development of e-commerce industry and the income of urban and rural residents in Caoxian County, in order to provide theoretical basis for the development of e-commerce industry in other counties to promote the income of urban and rural residents.

2. LITERATURE REVIEW

The income level of rural residents has always been a research hotspot in the academic circle. Many scholars have made in-depth analysis on the factors affecting the income level of rural residents by using various macro-panel data and micro-survey data. Chen et al. [4] concluded that macroeconomic growth has a positive promoting effect on the growth of rural residents' income and can promote the increase of rural residents' income. Some scholars have proposed that the level of regional Internet infrastructure construction can affect the income of rural residents, and the higher the level of Internet infrastructure construction, the more it can promote the income increase of rural residents. Wu et al.[5] believe that rural residents' use of the Internet for work purposes has a positive impact on improving rural residents' wage income. Jin et al. [6] proposed that Internet infrastructure construction can promote rural development and increase farmers' income, but Internet infrastructure construction will also widen the income gap between urban and rural areas. The country's vigorous implementation of the rural revitalization strategy can effectively promote the development of the economy and people's livelihood in rural areas and improve the income level of rural residents. Chen et al. [7] studied the relationship between the level of rural revitalization and the overall development of urban and rural areas, and found that the rural revitalization strategy effectively promoted the economic development of rural areas. Many scholars have proposed that the development of e-commerce industry can improve the income level of rural residents, and studied how to promote the development of e-commerce industry to increase the income of rural residents from different perspectives. Using the data of 288 prefecture-level cities, Wang [8] found that rural e-commerce directly increased the income of rural residents through different intermediary paths. Using data from the 2016 Sun Yat-sen University Labor Dynamics Survey (CLDS), Li et al. [9] found that e-commerce can boost the income of poor and non-poor households. However, some scholars believe that the development of e-commerce will widen the income gap between urban and rural areas due to the gap between urban and rural infrastructure and the lack of technical talents in rural areas. The development of e-commerce industry has a greater role in promoting the income of urban residents than that of rural residents, further widening the income gap between urban and rural residents. According to Chen et al. [10] digital economy can reduce the income gap between urban and rural areas in the early stage of development, but with the further development of digital economy, the income gap between urban and rural residents will be enlarged, and the digital divide between urban and rural areas will be generated.

Most of the existing literatures focus on using the macro panel data and some micro cross-section data of the national and provincial statistical yearbook to study the effects of macroeconomic development, Internet development level and the development of e-commerce industry on the improvement of rural residents' income, while few literatures study the income of rural residents at county level through county-level statistical data. Most of the existing literatures draw conclusions by mining and analyzing macro or micro data through econometric methods, while few literatures draw relevant conclusions by analyzing data through the method of grey system theory. Taking Caoxian County of Heze, Shandong Province as the research object, this paper studies the influence of the development of e-commerce industry on the income of urban and rural residents in Caoxian county through the method of grey relative correlation analysis, and analyzes the influence degree of the county e-commerce industry on the income types of urban residents and rural residents.

3. INFLUENCE MECHANISM AND INDEX SELECTION

3.1. Analysis of the Influence Mechanism of the Development of E-Commerce Industry on Residents' Income

The development of e-commerce industry can promote the improvement of residents' income level in a variety of ways, the most direct way is to provide a platform for the sale of agricultural products and provide farmers with effective information on the demand for agricultural products. The development of e-commerce industry can improve the quality of farmers' information acquisition, reduce the reduction of residents' income caused by middlemen earning difference in the circulation of agricultural products, and then increase farmers' sales income. Through the Internet, farmers can timely understand the market information, understand the market sales of various agricultural products and user needs, and optimize the planting and marketing decisions of agricultural products. The development of e-commerce industry can provide channels for farmers to start businesses. At the same time, e-commerce start-up costs are low and easy to get started. Most rural residents can normally operate e-commerce online stores after training. E-commerce sales can alleviate the contradiction between supply and demand of agricultural products, solve the problem of unsalable agricultural products, increase the sales of agricultural products, and increase the operating income of rural households. Therefore, this paper puts forward hypothesis 1: The development of county e-commerce industry can improve residents' operational income, and the impact on rural residents' income is higher than that of urban residents.

E-commerce industry can promote the development of cold chain logistics and other related industries, generate a large number of job demand, absorb labor employment. Through the development of e-commerce industry, the low-end labor force can master modern work skills and ease the employment pressure. The development of e-commerce industry can create new employment opportunities and employment positions, and rural residents can increase part of their income in the new employment opportunities created by e-commerce industry. The development of e-commerce industry can promote the development of local agricultural processing enterprises and related manufacturing industries, increase the demand for labor, and increase the number of jobs for residents. The development of e-commerce industry can promote the adjustment and upgrading of local industrial structure, so that the surplus rural labor force can flow from the primary industry to the second and third industries, which can improve the urban-rural income imbalance. The development of e-commerce industry can provide flexible and diverse employment methods and forms, and flexible working hours and workplaces can solve the work problems of some left-behind women and the elderly. They earn an income while taking care of their families and children. Therefore, this paper puts forward hypothesis 2: The development of county e-commerce industry can improve the wage income of rural residents, and the impact on the income of rural residents is higher than that of urban residents.

3.2. Index Selection

This paper takes Caoxian County of Heze City, Shandong Province as the research object, and the time series is 2017-2021. The research data mainly come from Heze Statistical Yearbook and Caoxian People's government work report. In this paper, based on the existing research results and considering the availability of data, the relevant indicators are selected. In recent years, the proportion of Taobao village and Taobao town in the local area has been increasing. The rural e-commerce industry has entered a stage of accelerated development, and the rise of Taobao villages and Taobao towns has a cluster effect, which can broaden farmers' sources of income. In this paper, the number of Taobao villages and the number of Taobao towns are selected as e-commerce cluster data to represent the development status of the local e-commerce industry [11], and the e-commerce sales in Caoxian County is selected to represent the development status of the local e-commerce industry. Residents'

disposable income is an index reflecting the living standard of urban and rural residents, which is composed of wage income, business income, property net income and transfer net income. Wage-based income refers to the wages obtained by the residents participating in the individual through the sale of labor force; Operational income refers to the monetary income obtained by residents engaged in production and business activities. The e-commerce industry can provide employment opportunities for rural labor in industrial sectors such as agricultural product processing, packaging and transportation, thereby increasing the wage income of rural labor [12]. In this paper, the wage income of urban and rural residents is selected as an indicator to reflect the income level of residents. The development of e-commerce can promote the transformation of the local industrial structure from the primary industry to the tertiary industry, and drive residents to start businesses in the form of family-style online shops. Therefore, this paper chooses resident business income as an indicator to reflect the level of resident income.

4. DATA SOURCE AND MODEL CONSTRUCTION

4.1. Data Source

Cao County, Heze, Shandong Province, is a revolutionary old area in southwest Shandong Province. As a traditional underdeveloped county and agricultural county, under the wave of e-commerce entering the countryside, the local entrepreneurial residents have driven the development of the local e-commerce industry and formed a super-large Taobao village and Taobao town cluster. Since 2012, the regional GDP of Caoxian County has increased from 22.66 billion yuan in 2012 to 52.95 billion yuan in 2021, an increase of 133.7%, rising from the 114th to the 54th place in the province. The per capita disposable income of urban residents in Caoxian County increased from 15,558 yuan to 31,948 yuan, and that of rural residents doubled from 8,073 yuan to 16,695 yuan. In recent years, Caoxian e-commerce industry from small to large, rapid development, Caoxian e-commerce sales increased from 12 billion yuan in 2017 to 28.1 billion yuan in 2021, an increase of 134.2%, the number of Caoxian Taobao villages increased from 74 in 2017 to 168 in 2021, an increase of 127.0%, The number of Taobao towns in Caoxian county increased from 9 to 19, an increase of 111%.

The development of e-commerce industry can improve the income of urban and rural residents through various income types, and thus enhance the wealth of local residents. During the five-year period from 2017 to 2021, the disposable income of rural residents in Caoxian County increased from 11,607 yuan to 16,695 yuan, of which wage income increased from 4,013 yuan to 5,125 yuan, and business income increased from 3,816 yuan to 6,399 yuan. The disposable income of urban residents in Caoxian County increased from 23,907 yuan in 2017 to 31,948 yuan in 2021, of which wage income increased from 10,118 yuan to 15,305 yuan. During the five years from 2017 to 2021, the income gap between urban and rural residents in Caoxian County, wage income decreased from 4,808 yuan to 2,390 yuan, and business income decreased from 5,005 yuan to 1,116 yuan.

4.2. Model Construction

Grey system theory, founded by Chinese scholar Professor Deng Julong in 1982, is a new method to study the problem of poor information uncertainty. The basic idea of grey correlation analysis is to judge whether different sequences are closely related according to the similarity of geometric shapes of sequence curves [13]. Grey correlation analysis is to measure and analyze the correlation degree of two variables in the system when they change with time or other factors. When the changes of the two selected variables have the same trend, it is considered that there is a correlation degree between them. Grey correlation analysis can be divided into Deng's grey correlation degree, grey absolute correlation degree, grey relative correlation degree and grey comprehensive correlation degree. The gray relative correlation degree is a representation of the relation between the change rates of the sequence X_i and X_j relative to the starting point. The closer the change rates of X_i and X_j are, the

larger the r_{ij} will be, and the smaller the r_{ij} will be [13]. Grey relative correlation analysis is to calculate the value according to the two factors with similar development trend, and express the mutual relationship between the two factors in the system through the value. In recent years, as a native theory of China, grey system theory has been widely applied in the fields of natural science, social science and engineering technology, and has become an effective tool for people to mine small data from massive data and has played an important role [14]. This paper takes the income of urban and rural residents as the research object, and studies the correlation between the development level of county e-commerce industry and the income of urban and rural residents through grey relative correlation analysis. Existing scholars mostly use regression analysis, correlation analysis and analysis of variance and other methods, most of which require a large number of samples for analysis. In this paper, the method of grey relative correlation analysis is chosen, which has less sample selection and high system stability. Grey relative correlation analysis is a multi-factor statistical analysis method, which can comprehensively consider the influencing factors of various indicators and build the interrelationship between various evaluation indicators. The sales volume of e-commerce industry, the disposable income of urban and rural residents and the composition of e-commerce industry have obvious incomplete information and small sample nature, which is a typical grey system.

Firstly, the reference sequence reflecting the characteristics of the system behavior and the comparison sequence affecting the system behavior are determined. The indicators of the development level of e-commerce are selected as the reference sequence, and the indicators of urban and rural residents' income are selected as the comparison sequence. Firstly, the reference sequence that reflects the characteristics of the system behavior and the comparison sequence that affects the system behavior are processed without dimension, so as to unify all kinds of indicators, facilitate research, and reduce the error value of the gray relative correlation degree. Secondly, the grey relative correlation analysis is carried out on the non-dimensional data.

(1) Set the dimensionless data as X_i and X_j to represent the development level of e-commerce and the income of urban and rural residents respectively

(2) Let the initial value image of the dimensionless data be obtained by the following formula

$$X'_i = \frac{X_i}{x_i(1)} \quad (1)$$

$$X'_j = \frac{X_j}{x_j(1)} \quad (2)$$

(3) For X'_i and X'_j , the beginning point zeroized image is obtained by the following formula

$$x_i^0(k) = x'_i(k) - x'_i(1) \quad (3)$$

$$x_j^0(k) = x'_j(k) - x'_j(1) \quad (4)$$

(4) Find $|s'_i|$, $|s'_j|$, $|s'_i - s'_j|$ namely

$$|s'_i| = \left| \sum_{k=2}^4 x_i^0(k) + \frac{1}{2} x'_i(5) \right| \quad (5)$$

$$|s'_j| = \left| \sum_{k=2}^4 x_j^0(k) + \frac{1}{2} x'_j(5) \right| \quad (6)$$

$$|s'_i - s'_j| = \left| \sum_{k=2}^4 (x_j^0(k) - x_i^0(k)) + \frac{1}{2} (x'_j(5) - x'_i(5)) \right| \quad (7)$$

(5) Calculate the grey relative correlation degree

$$r_{ij} = \frac{1+|s'_i|+|s'_j|}{1+|s'_i|+|s'_j|+|s'_i-s'_j|} \quad (8)$$

The data of each chart are as follows: After dimensionless processing, the data in Table 1 and Table 2 are obtained. Based on the gray relative correlation analysis of the data in Table 1 and 2, the gray correlation analysis matrix of the development of e-commerce industry and the income of urban and rural residents in Table 3 is obtained. The higher the correlation value of an evaluation index, the higher the impact of e-commerce development level on residents' income level.

Table 1. Income of non-dimensional urban and rural residents in Caoxian County from 2017 to 2021

A given year	Rural area			Urban area		
	Household disposable income	Wage-oriented income	Operational income	Household disposable income	Wage-oriented income	Operational income
2017	1.00	1.00	1.00	1.00	1.00	1.00
2018	1.09	1.39	0.57	1.08	0.99	1.08
2019	1.21	1.50	0.91	1.18	1.36	0.86
2020	1.29	1.59	1.19	1.22	1.41	1.05
2021	1.44	1.28	1.68	1.34	1.51	0.85

Table 2. 2017-2021 non-dimensional e-commerce industry development in Caoxian County

A given year	E-commerce development condition		
	E-commerce sales	Number of Taobao villages	Number of Taobao towns
2017	1.00	1.00	1.00
2018	1.32	1.53	1.22
2019	1.65	1.68	1.44
2020	1.30	2.04	1.89
2021	2.34	2.27	2.11

The size of the grey correlation index data reflects the promotion degree of the development level of e-commerce to the income level of residents. If the correlation degree value is low, it indicates that the development level of e-commerce has a low promotion degree to the income level of residents; if the correlation degree value is similar, it indicates that the development level of e-commerce has a close promotion degree to the different income levels of different residents. This paper refers to existing studies. Generally speaking, a correlation degree less than 0.4 indicates a low degree of correlation, a correlation degree between 0.4 and 0.6 indicates a moderate degree of correlation, a correlation degree between 0.6 and 0.8 indicates a high degree of correlation, and a correlation degree between 0.8 and 1.0 indicates a high degree of correlation.

Table 3. Results of grey correlation analysis between the development of e-commerce industry and the income of urban and rural residents

Resident income level	E-commerce development level		
	E-commerce sales	Number of Taobao villages	Number of Taobao towns
Disposable income of rural residents	0.768	0.694	0.751
Wage income of rural residents	0.934	0.813	0.907
Business income of rural residents	0.641	0.575	0.598
Disposable income of urban residents	0.736	0.670	0.721
Wage income of urban residents	0.811	0.724	0.791
Business income of urban residents	0.620	0.586	0.612

5. RESEARCH CONCLUSIONS AND IMPLICATIONS

Analysis results of correlation degree between industrial development and urban and rural residents' income: It can be seen from the data in Table 3 that the correlation results between the development of e-commerce industry and the disposable income of urban and rural residents are between 0.6 and 0.8, indicating a high degree of correlation between the two. During 2017-2021, the correlation between the number of Taobao villages and the disposable income of rural residents is 0.694, and that between the number of Taobao villages and the disposable income of urban residents is 0.670. The correlation between the number of Taobao towns and the disposable income of rural residents is 0.751, and the correlation between the number and the disposable income of urban residents is 0.721. The correlation between e-commerce sales and disposable income of rural residents is 0.768, and that between e-commerce sales and disposable income of urban residents is 0.736. Among the impacts on the disposable income of urban and rural residents, the development of e-commerce industry has a greater impact on the disposable income of rural residents than on the disposable income of urban residents. Specifically:

It can be seen from the data in Table 3 that the correlation between the development of e-commerce industry and the operational income of urban and rural residents is between 0.4 and 0.6, and the higher result can reach about 0.64, indicating that the development of e-commerce industry has a moderate correlation with the operational income of urban and rural residents. During 2017-2021, the correlation between the number of Taobao villages and the operational income of rural residents is 0.575, and that of urban residents is 0.586. The impact of the number of Taobao villages on the operational income of urban residents is greater than that of rural residents. The correlation between the number of Taobao towns and the operational income of rural residents is 0.598, and the correlation between the number of Taobao towns and the operational income of urban residents is 0.613. The impact of the number of Taobao towns on the operational income of urban residents is greater than that on the operational income of rural residents. The correlation between e-commerce sales and the operational income of rural residents is 0.641, and that between e-commerce sales and the operational income of urban residents is 0.620. The impact of e-commerce sales on the operational income of rural residents is greater than that on the operational income of urban residents. Through the above analysis, hypothesis 1 can be partially verified, and the development of e-commerce industry can promote the operational income of urban and rural residents. The development of county e-commerce industry can promote urban and rural residents to open online stores through Internet platforms, sell

products to the whole country, and increase household business income of urban and rural residents. At the same time, the development of county e-commerce industry can promote the development of related logistics industries, and urban and rural residents can increase their operational income by opening logistics outlets and logistics transportation companies.

According to the data in Table 3, the correlation degree between the development of e-commerce industry and the wage income of urban and rural residents is between 0.8 and 1.0, and the lower value can reach 0.72, indicating that the development of e-commerce industry has a very high correlation degree with the income of urban and rural residents. The correlation between the number of Taobao villages and the wage income of rural residents is 0.813, and the wage income of urban residents is 0.724. The influence of the number of Taobao villages on the wage income of rural residents is greater than that on the wage income of urban residents. The correlation degree between the number of Taobao towns and the wage income of rural residents is 0.907, and the correlation degree between the number of Taobao towns and the wage income of urban residents is 0.791. The impact of the number of Taobao towns on the wage income of rural residents is greater than that on the wage income of urban residents. The correlation between e-commerce sales and the wage income of rural residents is 0.934, and the correlation between e-commerce sales and the wage income of urban residents is 0.811. The impact of e-commerce sales on the wage income of rural residents is greater than that on the wage income of urban residents. Through the above analysis, hypothesis 2 is verified that the development of e-commerce industry can promote the increase of wage income of urban and rural residents, and the increase degree of wage income of rural residents is greater than that of urban residents. The rapid development of rural e-commerce industry has driven the development of logistics industry, agricultural product processing and manufacturing industry and other related industries, which can increase the employment of residents, make rural residents who originally have no jobs get an income, and then increase the wage income of rural residents. The development of e-commerce industry can provide a job for rural surplus labor force and rural left-behind women, so that they can obtain an income from enterprises in their spare time and take care of their families, and thus increase the wage income of rural residents.

6. POLICY SUGGESTIONS

In order to explore the impact of county e-commerce industry on residents' income, this paper uses grey relative correlation analysis method to analyze the grey relative correlation between Taobao village, Taobao town, e-commerce sales and urban and rural residents' income from 2017 to 2021 in Caoxian County, Heze, Shandong Province. Through the analysis of the development of Caoxian e-commerce industry and residents' income, the following research Revelations are obtained: First, county e-commerce can rely on the unique product resource advantages of the county to build an online sales platform and increase the sale of local products to the whole country. It is necessary to accelerate the construction of rural e-commerce infrastructure and digital upgrading, build cold chain logistics infrastructure for agricultural production areas, make up for the shortcomings of rural logistics infrastructure, and reduce the losses caused by logistics facilities to rural residents. Strengthen the relevant data statistics of rural e-commerce product sales, use big data to assist rural e-commerce enterprises in online sales, use big data to assist store operators in decision-making, improve decision-making accuracy, and reduce property losses caused by decision-making problems. Actively expand product sales channels to avoid product excess. Reasonable integration and unified planning should be carried out for the development of rural e-commerce to avoid vicious competition within the region and bring losses to residents. Second, the development of local Taobao villages and Taobao towns has played an important role in improving residents' income, and all construction cannot be separated from the people, but also for the people. Through the development of the village, the town's e-commerce industry, to attract migrant workers to return to their hometown employment. The local government should reasonably guide e-commerce practitioners to continuously expand product categories and implement "differentiated competition", thereby reducing the serious

homogeneity of products produced in Taobao Village and Taobao town and reducing the loss caused by "internal friction". At the same time, under the guidance of local governments, industry associations have been established to promote the development of enterprises in the region and improve the competitiveness of local products in the industry. Under the guidance of the government, the fruits of development benefit all the people, so that all the people can enjoy the dividends brought by the development of the e-commerce industry in the region. The government should implement precise policies to help e-commerce enterprises, increase the training of e-commerce skills for local people, and give full play to the role of the government so that all people can profit from the development of e-commerce industry.

Vigorously develop cross-border e-commerce and help the development of agricultural e-commerce, innovate the development model of e-commerce industry, promote the digital transformation of the development of e-commerce industry, and promote the high-quality development of regional economy. The development of e-commerce industry provides opportunities for farmers to break through the original market segmentation, and becomes an effective way to promote rural residents to increase their income. At the same time, the development of regional e-commerce industry enables the low-skilled labor force existing in rural areas to get employment opportunities in the process of upgrading the economic structure and avoid structural unemployment. Therefore, it is necessary to increase support for the development of e-commerce industry in rural areas and promote it to other rural areas. Carry out government-enterprise cooperation to solve the problems existing in the development of e-commerce industry in rural areas.

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