Internet+ Agriculture: An Empirical Perspective of the Internet Effect in Agricultural Economy

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Abstract. In order to study the role and impact of the Internet on the growth of China’s agricultural economy and to promote the development of the Internet+ agricultural economy better, this paper chooses key indicators of the Internet to construct the Economic Effect Panel Model of the Internet+ agriculture. The test results show that 1) the Internet has a positive impact on agricultural economic growth. 2) Among the individual effects, the regional differences are obvious; agricultural products have distinctive characteristics; and the effect of Internet+ is more prominent in the regions of developed agricultural tourism. 3) the period effect before 2010 was negative, and after 2011 it became positive and this positive effect was increasing year by year. Based on the test results, some corresponding countermeasures and suggestions were made: 1) to increase the investment of Internet in agriculture, especially in special agriculture. For example, some kinds of agricultural tourism Internet projects should be used. 2) to enlarge investment of agricultural Internet and Internet of Things in agricultural fiscal spending, in agricultural fixed assets investment and in the construction of farmland infrastructure. 3) to strengthen talents training of Internet+ agricultural, and to improve the Making of Internet+ agricultural standards.

Keywords: Internet+, Agricultural economy, Panel model, economic growth

1. Introduction

In 2018, the added value of China's agriculture was 6473.4 billion yuan, accounting for 7.19% of GDP, which takes up a smaller and smaller proportion of the entire economic structure. However, with the development of the economy, the basic role of agriculture has become more and more obvious. Knowledge-based Agriculture formed by using new technologies such as the Internet, the Internet of Things, and big data is the fundamental way out for agriculture.

The development of Knowledge-based Agriculture has become an important task at the national level. The state has also given many supportive policies in the field of Knowledge-based Agriculture and it’s industrialization. For many years, the no. 1 document of the CPC Central Committee has related report about Knowledge-based Agriculture. In 2018, the Central Committee's No.1 document proposed to develop digital agriculture vigorously, implement Knowledge-based Agriculture forestry and water Conservancy projects, and promotes the use of Internet of Things test demonstration and remote sensing technology. In 2019, the
Central Government’s No.1 document proposed the implementation of technology-focused agriculture, including Knowledge-based Agriculture. With the rapid development of the Internet and the implementation of China’s rural revitalization strategy, agriculture is being reconstructed and upgraded by new technologies such as the Internet, big data, and artificial intelligence. The Internet has become an important facility for agricultural development. Since the implementation of the Internet+ Strategy in China, Agriculture is also gaining new strength.

Therefore, we need to understand the impact of the Internet on the agricultural economy, the extent and trend of the impact of the Internet on the agricultural economy. So as to facilitate the implementation of the Internet+ agricultural strategy better, put forward agricultural Internet development countermeasures better, and promote agricultural economic growth, the panel model of Internet+ agricultural economic effect was established, and data of Internet, agricultural financial expenditure, agricultural fixed investment and agricultural economic added value from 2007 to 2017 were collected for demonstration, providing theoretical support and practical reference for the in-depth implementation of Internet+ agricultural strategy.

2. Literature Review

In order to develop agricultural economy in an efficient, ecological and sustainable way, the government of China always gives priority to the development of agriculture and rural areas, takes rural revitalization as the overall starting point, and takes Knowledge-based Agriculture of Internet+ as an important means. As an economic developmental tool, Internet plays an important role in economic development. Qi Li (1999) pointed out that e-commerce is a new productive force [1]. Metcalfe’s law summarized the Internet economy and pointed out that the effect of Internet economy is related to the number and quality of nodes. Moore’s law points out the dynamic evolution of information economics, in which the performance of information products in the next cycle is more than doubled than the previous cycle, but the price may be half of the original. Making good use of these tools and their economic characteristics in the field of agriculture can accelerate the development of agricultural economy and stimulate the effect of agricultural economy. Research on Internet+ agriculture is mostly focused on e-commerce in rural areas, the Internet of things in agriculture, agricultural marketing and other aspects. The main viewpoints include the positive influence of Internet on agriculture and rural development; the promotion of Internet on marketing and brand communication of agricultural products. Agricultural Internet of things and agricultural e-commerce will become the infrastructure of Knowledge-based Agriculture.

About the economic effects of the Internet, Liwei Li, Yufei Mao and others mainly chose Internet penetration rate as the main factor to analyze its impact on economic growth [2]. Guanghai Tang and Ruili Chu focused on Internet penetration rate, number of websites, number of domain names and other indicators [3], while Yincheng Xie and Jie Gao et al. chose number of mobile users, number of websites, number of domain names and number of online shopping users as Internet factors to study the impact of Internet on economic growth [4]. All in all, according to the research process and conclusion, 1) Internet penetration rate represents the trend of Internet technology diffusion in the early stage of Internet development, but in the long run, the number of Internet websites and domain names can more steadily represent the distribution or investment factors of Internet resources. 2) Factors that have a direct impact on agricultural economy include the amount of irrigated farmland [5], agricultural financial expenditure and fixed investment in agricultural industry and so on [6].

3. Model Construction and Data Sources

3.1 Model construction

When studying the influencing factors of agricultural economy, c-d function is generally established to reflect the relationship between input and output, and logarithm of the function is taken to build the model as follows:

\[
\ln P_{gda} = c + k_{\text{Internet}} + k_{\text{Contral}} + \epsilon
\]  

(1)
In formula (1), $P_{gdpa}$ represents the added value of the explained variable, and Internet represents the input of Internet elements. Control stands for control variable. Among Internet elements, the number of websites ($P_{wz}$) and the number of domain names ($P_{ym}$) are the main elements. The control variables of agricultural economic effect test are mainly the quantity of available farmland resources for irrigation ($P_{nt}$), agricultural financial input ($P_{cz}$) and agricultural fixed assets input ($P_{gd}$). Therefore, the above model can be refined into:

$$\ln P_{gdpa} = c + k_1 \ln P_{wz} + k_2 \ln P_{ym} + k_3 P_{nt} + k_4 P_{cz} + k_5 P_{gd} + \varepsilon$$

(2)

### 3.2 Data sources

The data in the model are from *The Statistical Yearbook of China* and *The Statistical Report on the Development of China’s Internet from 2008 to 2018*. The above data does not include China’s Hong Kong, Macao and Taiwan. As table 1 shows: 1) the standard deviation of the agricultural economic added value per capita of each province, autonomous region and municipality is greater than 0.50, and there is a significant difference among different regions. 2) The standard deviation of the number of websites and the number of domain names in the input of network resources is greater than 1.12, which shows an obvious regional difference.

### Table 1 descriptive statistical analysis results of the data

|            | Mean  | Median | Maximum | Minimum | Std. Dev. | Observations |
|------------|-------|--------|---------|---------|-----------|--------------|
| $\ln P_{wz}$ | 2.3617 | 2.2246 | 5.7839  | 0.1405  | 1.1272    | 341          |
| $\ln P_{ym}$ | 4.1483 | 3.9160 | 8.2077  | 1.8375  | 1.1953    | 341          |
| $\ln P_{nt}$ | 6.8230 | 6.7179 | 8.2993  | 5.7011  | 0.5120    | 341          |
| $\ln P_{cz}$ | 7.5579 | 7.6064 | 9.7808  | 5.5134  | 0.8416    | 341          |
| $\ln P_{gd}$ | 7.4065 | 7.3883 | 9.4154  | 3.9890  | 0.9618    | 341          |
| $\ln P_{gdpa}$ | 8.8428 | 8.8834 | 10.1167 | 7.4043  | 0.5054    | 341          |
| $\ln P_{nym}$ | 9.4112 | 9.4400 | 10.5525 | 7.8725  | 0.5150    | 341          |

### 4. Analysis of Measurement Results

In order to avoid the model’s pseudo-regression problem and the long-term equilibrium relationship between variables, the above model was tested by unit root test and co-integration test. The results showed that there was no pseudo-regression problem in the model, and there was a long-term equilibrium relationship among the increase of total agricultural output and the number of websites, number of domain names, agricultural financial expenditure, agricultural fixed investment and other variables.

#### 4.1 The impact of Internet on the increase of agricultural economy

Eviews is used to test the model, and there are three kinds of models: fixed effect, random effect and mixed effect. *F Test* is used to evaluate whether mixed effect model is applicable to the selected model, and *Hansman* is used to select fixed effect and random effect model. Model selection and test results are shown in table 2.

### Table 2 Test results of the influence of Internet on the increase of agricultural economy

|            | Per capita increase in total agricultural output ($\ln P_{gdpa}$) |
|------------|--------------------------------------------------------------|
|            | Model 1 | Model 2 | Model 3 | Model 4 |
| $\ln P_{wz}$ | 0.064714$^*$   | 0.035931$^*$   | 0.003203$^*$   | |
|            | (1.852186)   | (1.001597)   | (0.132419)   | |
| $\ln P_{ym}$ | 0.072279**   | 0.066098**   | 0.013937**   | |
|            | (3.333046)   | 2.931685    | (0.903571)   | |
| $\ln P_{nt}$ | 0.507533***  | 0.507533***  | 0.507533***  | |
|            | (10.38973)   | (10.38973)  | (10.38973)  | |
| $\ln P_{cz}$ | 0.285778**   | 0.285778**   | 0.285778**   | |
|            | (5.591325)   | (5.591325)  | (5.591325)  | |
Per capita increase in total agricultural output (LnPgdpa)

| LnPgd | Model 1  | Model 2  | Model 3  | Model 4  |
|-------|----------|----------|----------|----------|
|       |          |          |          | 0.139499*** |
|       |          |          |          | (9.945786) |
| C     | 8.690017*** | 8.543016*** | 8.483797*** | 2.121483*** |
|       | (104.9123) | (94.66866) | (78.638000) | (4.888575) |
| R²    | 0.938533  | 0.940055  | 0.940256  | 0.973296  |
| model | FE       | FE       | FE       | FE       |

Note: FE is a fixed-effect model. *, ** and *** stand for that it is significant at 10%, 5% and 1% levels, respectively.

In table 2, model 1-3 mainly discusses the economic effects of the number of websites, the number of domain names and their combination on the increase of agricultural economy. Model 4 covers Internet resource input and agricultural economic effect test under agricultural economic environment. The results show that the number of websites and domain names have a significant effect on the increase of agricultural economy.

In model 1-2, the impact of the increase in the number of websites or domain names on the increase of agricultural economy was considered separately, and the elasticity coefficients were 0.064714 and 0.072279, respectively. It is significant that the number of websites increased at 10% level, and the number of domain names increased at 5% level. It can be seen that the input of regional Internet resources promotes the increase of agricultural economy.

Model 3 covers the cross effect of the increased number of websites and the number of domain names on the increase of agricultural economy. The elasticity coefficient of the increase of domain names is larger than that of the number of websites. It can be seen that the scale effect of Internet resource investment is still growing.

In model 4 points out that the input of Internet resources and the main environmental variables of agricultural economy, the increase of the number of websites and domain names has a positive impact on the increase of agricultural economy. At the same time, the increase of irrigated agriculture, agricultural financial expenditure and agricultural fixed investment are closely related to agricultural economic growth.

### 4.2 Individual effects of the Internet on the increase of agricultural economy

In order to further analyze the regional individual differences of the Internet and the increase of agricultural economy, as well as the manifestation of such differences in the effect of the Internet on agricultural economy, the fixed effect model is adopted to fix the individual. The individual effect of the Internet on the increase of agricultural economy is shown in table 3.

#### Table 3 The individual effects of the Internet on the increase of agricultural economy

| Regions  | Individual effect | Regions  | Individual effect | Regions  | Individual effect |
|----------|-------------------|----------|-------------------|----------|-------------------|
| HAINAN   | 1.036294          | SHANDONG | 0.251774          | GANSU    | -0.29078          |
| FUJIAN   | 0.653113          | HENAN    | 0.121546          | NEIMENGGU| -0.343488         |
| GUANGDONG| 0.603099          | YUNNAN   | 0.12123           | QINGHAI  | -0.374011         |
| GUANGXI  | 0.481311          | GUIZHOU  | 0.107155          | XINJIANG | -0.474674         |
| NIAOLIN  | 0.407851          | HEBEI    | 0.084187          | SHANGHAI | -0.515752         |
| HUBEI    | 0.376723          | JIANGXI  | 0.063684          | SHANXI   | -0.590262         |
| SICHUAN  | 0.372747          | SHAANXI  | 0.042562          | TIANJING | -0.595336         |
| HUNAN    | 0.309343          | JILIN    | 0.023275          | NINGXIA  | -0.678419         |
| JIANGSU  | 0.279523          | ANHUI    | -0.046344         | BEIJING  | -0.72198          |
| CHON QING| 0.271122          | HELONG JIANG | -0.244223       | XIZANG   | -1.001736         |
| ZHEJIANG | 0.270466          |          |                   |          |                   |

Table 3 shows the individual impact of Internet on the increase of agricultural economy. There are 19 regions which has a positive impact of Internet input on the increase of agricultural economy and 12 regions which has a negative impact. The influence of Internet on agricultural economy is the greatest in Hainan,
which is related to its tourism’s publicity and promotion with the help of Internet and its distinctive agricultural products. The individual effect of Beijing, Tianjin and Shanghai is lower than others, which is mainly related to the higher degree of urbanization in these three places. The individual effects of other provinces, municipalities and autonomous regions are basically matched with the development status of the Internet and the degree of agricultural economic development.

4.3 The period effect of the Internet on the increase of agricultural economy

In order to analyze the period effect of the Internet on the increase of agricultural economy and understand the different stages of the development of the Internet on the economic effect of the increase of agricultural economy, The Period Fixed in the fixed effect model was used to obtain the analysis results as shown in table 4.

Table 4 The period effect of Internet on the increase of agricultural economy

| Year | Effect  | Year | Effect  |
|------|---------|------|---------|
| 2007 | -0.541922 | 2013 | 0.194932 |
| 2008 | -0.420935 | 2014 | 0.240368 |
| 2009 | -0.352272 | 2015 | 0.247658 |
| 2010 | -0.134199 | 2016 | 0.29617 |
| 2011 | 0.048834  | 2017 | 0.27919 |
| 2012 | 0.142175  |      |         |

Table 4 shows that the period effect of the Internet on the increase of agricultural economy can be divided into two stages. The first stage is before 2010, the period effect of Internet on the increases of agricultural economy is negative. The development of the Internet and the increase of Internet investment may take up the expenditure and fixed investment of the agricultural industry. The agricultural economic effect of Internet resources may also form a lag effect.

With the performance of the effect of Internet investment, since 2011, the economic effect of the Internet on the increase of agricultural economy has been positive and keep increasing. At this stage, as to Internet applications, smart phones played an very important role to break down agricultural barriers. This phenomenon match with the statistics of e-commerce user growth mainly from small and medium-sized towns and villages.

5. Confirmatory test

In order to further verify the effect model and analysis conclusion of the Internet on agricultural economy, the explanatory variable was replaced by the total agricultural output value and put into model (2) for testing. The results are shown in table 5.

Table 5 Economic effects of Internet on total agricultural output

| Total Agricultural Output (Ln\(Nyz\)) | Model 1   | Model 2   | Model 3   | Model 4   |
|---------------------------------------|-----------|-----------|-----------|-----------|
| Ln\(Pwz\)                            | 0.076812***| 0.051245* | 0.018716* |           |
| (2.167738)                            |           | (1.403829)| (0.752765)|           |
| Ln\(Pym\)                            | 0.067527***| 0.058713**| 0.005460**|           |
| (3.055260)                            |           | (2.559171)| (0.345309)|           |
| Ln\(Pnt\)                            |           |           |           | 0.535069***|
| (10.68524)                           |           |           |           |           |
| Ln\(Pcz\)                            |           |           |           | 0.278928***|
| (10.68524)                           |           |           |           |           |
| Ln\(Pg\)                             |           |           |           | 0.136208***|
| (9.473423)                           |           |           |           |           |
| C                                    | 9.229768***| 9.131048***| 9.046591***| 2.576609***|
| (109.8726)                           | (99.27812)| (82.40746)| (5.791974)|           |
| R²                                   | 0.939137   | 0.940023  | 0.940417  | 0.972972  |
| model                                | FE        | FE        | FE        | FE        |
Note: FE is a fixed-effect model. *, ** and *** stand for that it is significant at 10%, 5% and 1% levels, respectively.

Table 5 shows that the increase of the number of websites and domain names in the development of the Internet has a positive impact on the total agricultural output value. The economic effect of the increase in the number of websites on the total agricultural output value is significant at the level of 10%, while the economic effect of the increase in the number of domain names on the total agricultural output value is significant at the level of 5%. Among the control variables, irrigated farmland, agricultural financial expenditure and agricultural fixed asset investment have a significant influences on the total agricultural output value at the level of 1%. The conclusion is basically consistent with the economic effect of Internet on the increase of agricultural economy.

6. Conclusions and Suggestions

6.1 Conclusions
The analysis of the relationship between Internet resources and the increase of agricultural economy shows that the Internet has a significant economic effect on the increase of agricultural economy, and the economic effect of Internet+ agriculture in China has begun to appear in 2011, and this effect is still increasing in recent years. In the process of the agricultural economy development, therefore, we should 1) pay attention to the application of Internet tools in agriculture; 2) increase investment in agricultural Internet of things, big data of agriculture and agricultural materials e-commerce, agricultural products e-commerce as so on; 3) strengthen brand website of local agricultural products, APP and the construction of small programs; 4) make use of Internet tools and thinking; 5) implement the knowledge-based agriculture strategy of Internet+ agriculture; 6) promote agricultural economic growth.

6.2 Suggestions
Based on the above conclusions, four detailed suggestions are proposed.

(1) China should strengthen the knowledge-based agriculture planning of Internet+ agriculture, adjust measures to local conditions; plan knowledge-based agriculture based on geographical advantages and special products in the region; and strengthen the resource investment, personnel training and e-commerce sales standard construction of agricultural Internet.

(2) China should strengthen the construction of local agricultural brand websites, e-commerce, Internet of things and the investment of big data; build the brand websites, APP, small program and WeChat official account of local agricultural products; conduct publicity and promotion of agricultural products brands, build or make use of e-commerce websites to expand the sales market of agricultural products; provide better information services for consumers; lower the price of high-quality agricultural products purchased by consumers; and increase the income of agricultural planting and breeding by e-commerce to reduce the cost of agricultural materials needed for farming; strengthen the development of projects related to the Internet of things and big data in agricultural production to support further transformation and upgrading of the agricultural industry.

(3) China should strengthen talents training of Internet+ agricultural. Under the Internet+ agriculture strategy, new compound farmers with specialized agricultural skills and Internet knowledge are required. So talent introduction and training should be increased. Specialized talents in Internet operations, e-commerce, the Internet of things and big data should be introduced. The integrated development of the Internet+ agriculture should be promoted in the light of the actual development of the agricultural industry. The training of Internet knowledge and skills for the existing agricultural breeding experts is seriously needed. Based on the needs of agriculture, we should strengthen the investment in agricultural Internet, realize the deep integration of Internet and agriculture, and promote regional agricultural economic growth.

(4) China should strengthen the construction of related standards for Internet+ agriculture; establish Internet+ agriculture standards based on geographical advantages, agricultural products brands and market demands; establish e-commerce sales standards for agricultural products, based on market-oriented strategy;
achieve a mechanism for the production and marketing of agricultural products; reduce the transaction costs of agricultural products; improve consumers’ satisfaction and farmers’ income; We should establish standards for farming materials, seeds, fertilizers and management to ensure the standardization of agricultural production and agricultural products.

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