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Can rural e-commerce service centers improve farmers' subject well-being? A new practice of 'internet plus rural public services' from China

RESEARCH ARTICLE

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Abstract

Whether farmers live happily or not matters a nation's harmony and stability. Recently, a large number of rural e-commerce service centers (RESC) have been emerged in rural China. RESC provide some convenient services for local residents, such as agent purchase, sales, and payment online. This paper devotes to empirically analyzing the impact of RESC on farmers' subjective well-being (SWB) with the method of propensity score matching based on the survey data collected from the first pilot city of Alibaba's RESC project – Tonglu County, Zhejiang Province. It is confirmed that RESC can significantly improve farmers' SWB, which not only provides an empirical evidence for the further development of RESC, but also reveals that RESC is a beneficial practice for local governments to utilize the internet to improve farmers' welfare. It also has a positive exemplary significance for 'internet plus rural public services'.

Keywords: rural e-commerce, rural public services, subjective well-being, propensity score matching, China
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1. Introduction

It is well known that whether farmers live happily or not matters a nation's harmony and stability, especially for China – a country with more than 500 million rural residents (Chen *et al.*, 2016; Li and Wang, 2015). Hence improving farmers' happiness is one of the main tasks for the rural development in China. The subjective well-being (SWB) is a comprehensive indicator to measure residents' living conditions and happiness (Easterlin, 2003). It reflects residents' psychological satisfaction for their wealth and quality of life completely and reasonably (Asadullah and Chaudhury, 2012). Different from objective welfare indicators such as income or economic growth, the application of SWB would be helpful to avoid policy errors caused by the theoretical hypothesis of economic utility maximization (Tan and Wu, 2014).

In view of the great significance of SWB, many scholars have studied its measurement and influencing factors. There are a number of methods to measure individual's SWB, such as the SWB composite index (Kahneman and Krueger, 2006), the self-report scale (Krueger and Schkade, 2008), etc., among which self-report scale is the most commonly used (Chen *et al.*, 2016; Krueger and Schkade, 2008; Li and Wang, 2015; Tan and Wu, 2014). The researches on the influencing factors can be traced back to Easterlin's (1974) paper. In a long period of time, residents' income level was the ultimate goal pursued by the government, which implicitly assumed that income and SWB were basically the same. But the empirical observations were inconsistent (Easterlin, 1974). Easterlin (1974) pointed out that the growth of residents' income did not necessarily lead to the improvement of residents' SWB. After that, more and more scholars began to pay attention to SWB and its influencing factors, such as Diener and Diener (1995), Clark and Oswald (1996), Frey and Stutzer (2002), Ball and Chernova (2008), etc. In China, farmers' SWB and its influencing factors have gradually drawn scholar's attention. It is found that the income level is an important factor affecting Chinese farmers' SWB (Bai, 2015; Li and Wang, 2015; Liao, 2014; Shen *et al.*, 2014). Wang (2010) found that the consumption channels in rural China were blocked, which negatively affected the convenience and safety of rural consumers' shopping, thus reducing the happiness of farmers. Li and Chen (2012) suggested that good social relations can give farmers spiritual or material help, and increase their self-esteem and self-confidence, thus positively affecting their SWB. Besides, age (Bai and Wu, 2017), gender (Bian and Xiao, 2014), education (Huang *et al.*, 2017), land property rights (Wu *et al.*, 2009), endowment insurance (Cui, 2015), and other factors were also considered to affect farmers' SWB.

Recently, e-commerce, booming in rural China, has been effectively improving the income of farmers and open up rural consumption channels, which may improve the SWB of farmers. In 2016, the rural e-commerce consumption market has reached 482.3 billion yuan, which is 36.6% more than last year; the online sales of agricultural products have reached 220 billion yuan, which is 46% more than last year[1]. The rural e-commerce has been developing steadily and rapidly with more than 200 million rural internet users and 1,311 Taobao-villages[2]. Rural e-commerce service centers (RESC), as an important support and offline carrier of e-commerce, provide local rural residents with a range of services, such as agent purchase, sales, and payment online (Jin, 2019). So far, the number of RESC has exceeded 250,000[3], covering more than 1,500 counties and 420,000 villages in China[4]. Local governments actively cooperate with e-commerce enterprises by providing financial subsidies for the RESC, so as to improve rural public services and rural residents' happiness (Cai *et al.*, 2019). However, whether RESC can effectively improve the SWB of farmers in rural China?

No one has clearly answered the question above, although many researchers have carried out a series of studies on rural e-commerce in China. Zeng *et al.* (2015) found that rural e-commerce provided more opportunities for farmers to start a business and increased their incomes. Wang (2010), Zeng and Guo (2016) pointed that RESC provided online agent purchase for rural residents, so that local residents could buy the things from

[1] Data from 2016 China online retail market data monitoring report. Available at: http://www.100ec.cn/zt/wllsbg/ (in Chinese)
[2] Data from the Farmer Daily. Available at: http://hnny.rednet.cn/c/2017/03/02/4225857.htm (in Chinese)
[3] Data from the website of the Ministry of Commerce of China. Available at: http://www.ebrun.com/20160206/165425.shtml (in Chinese)
[4] Data from the Economic Reference. Available at: http://www.bosidata.com/news/S02716NOV6.html (in Chinese)

all over the country without leaving the village. E-commerce not only provides smallholders access to the larger online market but also benefits both the producer and the customer by eliminating the middleman and marketing constraints such as information asymmetry (Zeng *et al.*, 2018). In addition, e-commerce is helpful to improve infrastructure construction in rural areas (Fang, 2016), resolve rural social problems such as rural hollowing (Liu *et al.*, 2010), and reduce the fertilizer usage (Jin, 2019).

This paper aims to examine how RESC affect farmers' SWB. We study this theme not only because of the existing research gap, but also because of the great significance of SWB. Firstly, studying SWB could make clear whether the government's rural development policies and financial subsidies for RESC meet the needs of farmers, and whether they bring happiness to farmers, which is even more important. With the rapid development of rural e-commerce and RESC, there are more ways for local governments to provide public services to the rural areas. However, some local officials, in order to pursue their political achievements or records in their official careers, may provide some public goods or services that farmers do not need, such as vanity projects. Our research could make these issues clear. Secondly, SWB could reflect residents' psychological satisfaction for their wealth and quality of life more completely than other indicators, such as the level of income and consumption (Easterlin, 2003). Local governments provide financial subsidies for RESC as a kind of rural public services and rural development policies, whose ultimate goal is to improve rural residents' SWB.

The rest of this paper is organized as follows. Section 2 introduces the development process and service content of RESC. Section 3 depicts the empirical method, data source and variable description. Section 4 reports and analyzes the empirical results. Section 5 concludes this paper.

2. Brief introduction of rural e-commerce service centers and theoretical analysis

2.1 Brief introduction of rural e-commerce service centers

RESC is a new product of 'internet plus rural public services', and an important support and offline carrier of e-commerce in the field of rural public services. RESC mainly provide agent purchase and sales services, help to solve the problem of 'difficult to buy and sell' in rural areas, aiming to realize the two-way circulation of 'online goods to the countryside' and 'agricultural products to the city'. RESC also provide other services such as fee payment, reservation of hotel and ticket, information service, and so on (Figure 1). At present, RESC mainly include 'Rural Taobao' project of Alibaba Group, 'Jingdong Bang' project of JD Group, 'Rural Ule Shopping' of China Post Group, and 'Ganjie service center' of Zhejiang Ganjie E-commerce Co., Ltd. These kinds of RESC have different business modes and belong to different companies, but their functions are similar.

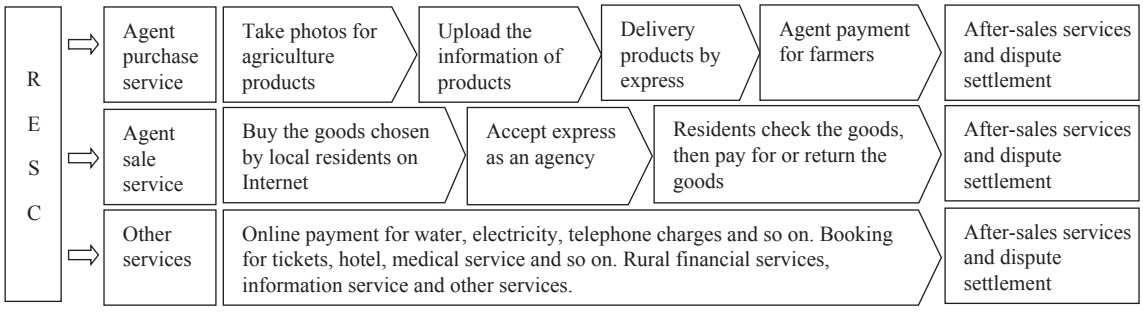

Figure 1. Functional process of rural e-commerce service centers (RESC).

The first RESC was initiated in Suichang County, Zhejiang Province by Zhejiang Ganjie E-commerce Co., Ltd. Then Alibaba and other large e-commerce companies launched their own RESC plans, which spread rapidly across the country. Generally, the RESC development process can be divided into three stages: (1) initial stage; (2) outbreak stage; and (3) perfection stage.

■ *Initial stage*

In June 2013, Ganjie E-commerce Co., Ltd. established the first RESC in Suichang County, namely Ganjie Service Center (GSC). The operation mode of GSC is that Ganjie E-commerce Co., Ltd. cooperates with the convenience stores in each selected village and provides free network equipment and training for the shopkeepers of convenience stores. Then the shopkeepers become the manager of GSC and provide agent purchase and sale service for local residents in their own convenience stores. GSC was favored by the local farmers soon, especially the farmers who were not skilled in computer and internet. However, the number of GSC did not increase rapidly that time. By the end of August 2014, there were only 41 county-level operation centers of GSC in China. The reasons why GSC expanded slowly were as follows: firstly, the success of the first GSC cannot be separated from the high-quality special agricultural product resources of Suichang County, which is hard to be copied by other regions; secondly, Ganjie E-commerce Co., Ltd. did not have enough capital to expand their business territory.

■ *Outbreak stage*

In October 2014, Alibaba group launched 'Rural Taobao' Project, investing more than 10 billion yuan to create a rural e-commerce service system covering 'thousands of counties and villages'. Then Alibaba Group established the first Rural Taobao Service CenterS (RTSC) in Tonglu County, Zhejiang Province. After that, RTSC sprung up across the country, because of Alibaba's abundant funds. In January 2015, JD Group, SUNING Group and China Post Group respectively launched 'Jinddong Bang', 'Suning E-shopping' and 'Rural Ule Shopping' to compete for the commercial territory of RESC, which caused explosive growth of the number of RESC. By the end of 2015, the number of RESC had exceeded 10,000[5]. However, since most of RESC managers were the shopkeepers of convenience stores, and lack of systematic training under the 'commercial territory race of RESC', they generally could not provide comprehensive and professional services efficiently and also couldn't fully meet the needs of local villagers, which made villagers' participation enthusiasm stay low. This bad circumstance would further damp the RESC managers' enthusiasm, which made a vicious circle. Finally, a number of RESC were just empty shells and some RESC managers withdrew from the agreement. In this stage, the 'commercial territory race of RESC' achieved a sharp increase in the number of RESC, but this 'superficial prosperity' was neither conducive to show the real function and value of the service centers, nor conducive to the sustainable development of the rural e-commerce market.

■ *Perfection stage*

In order to solve the problems during the outbreak stage, such as part-time managers of RESC that were unprofessional and difficulties to meet the needs of rural e-commerce, Alibaba took the lead in changing the operation mode of RESC. Alibaba began to select the migrant workers and college graduates with high entrepreneurial enthusiasm, outstanding innovation ability, and excellent professional quality by using specialized examination as the full-time manager of RTSC, and offered them remuneration and relevant training. The new operation mode not only effectively improved the professional level and service quality of RESC, but also provided opportunities for migrant workers and college graduates to return to hometown and start their own businesses. After that, the new operation was followed by other RESC, like 'Jinddong Bang', 'Suning E-shopping', and 'Rural Ule Shopping'. In order to promote farmers to sell more agricultural products through RESC, these e-commerce companies connected their RESC with other e-commerce

[5] Data from the first anniversary conference of Taobao University's e-commerce Seminar. Available at: http://news.yesky.com/111/99606111.shtml (in Chinese)

platforms to expand online sales channels. For example, Alibaba have realized the interconnection between RTSC, Taobao, Tmall and other e-commerce platforms, so as to promote the resource sharing among various platforms and optimize the functional structure of RTSC. So far, the number of RESC has exceeded 250,000, covering more than 1,500 counties and 420,000 villages in China.

2.2 Theoretical analysis

Based on the background mentioned above, the influence mechanism of RESC on farmers' SWB can be explained as follows (Figure 2). RESC mainly affect farmers' daily life and SWB by providing agent purchase, agent sale and other convenient services.

Thanks to the agent sale services of RESC, it is more convenient for the local agricultural products to embrace the whole network market. Moreover, it provides agricultural products with a green channel to cities and then effectively solve the problem of 'selling difficulty' for some special agricultural products, which offers farmers more opportunities in terms of entrepreneurship and income increase (Zeng *et al.*, 2015). The entrepreneurial opportunities brought by rural e-commerce attract more 'new farmers' (mainly composed of excellent migrant workers and college graduates) to join the army of returning hometown to start businesses (Cui *et al.*, 2014). The return of these new farmers alleviated the social phenomenon of 'empty nest elderly' and 'left over children', and promoted the construction of rural urbanization (Fang, 2016). In the process of rural urbanization, it not only strengthens the construction and improvement of local infrastructure, but also attracts more new farmers to return to their hometown to start businesses and increase their income, thus forming a virtuous circle. It should be noted that farmers' income (Liao, 2014), rural infrastructure (Peng and Lai, 2008), urban-rural dualistic differences (Luo, 2006), 'empty-nest elderly', and 'left-behind children' (Cui, 2015; Xu *et al.*, 2017) are all important factors affecting farmers' SWB. Therefore, RESC can improve farmers' SWB by promoting entrepreneurship and income increase.

The RESC enable farmers to buy goods from all over the country without leaving the village as it provides purchasing service, which helps pave the way for industrial products to enter the countryside, and solve the problem of 'difficult to buy' in rural areas in the past (Zeng and Guo, 2016). On the other hand, the RESC can effectively promote the urbanization development and infrastructure improvement in rural areas, which is conducive to the entry of local shopping malls or supermarkets, equivalent to expanding the offline consumption channels. In short, poor consumption channels in rural areas will negatively affect farmers' well-being (Wang, 2010) while e-commerce service centers can improve farmers' SWB.

Besides the agent sales and purchase services, other functions of RESC could also help to improve farmers' SWB. Firstly, RESC provide the agent payment and booking services, such as payment for telephone charges and booking for train tickets, which bring convenience to local rural residents and improve their SWB. It's not convenient to finish the water, electricity, telephone payments or do some booking in rural China, especially

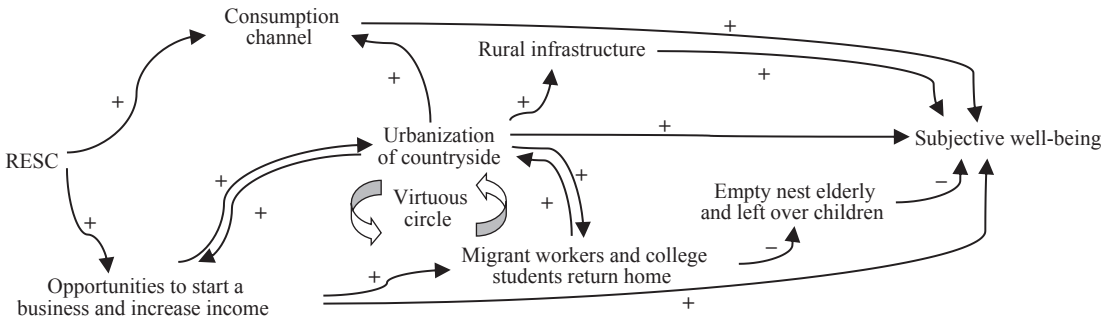

Figure 2. The influence mechanism of rural e-commerce service centers (RESC) on farmers' subjective well-being.

for the old and other farmers who do not know how to use the internet (Jin, 2019). It is helpful to improve these farmers' SWB if their daily problems could be solved. Secondly, RESC provide micro financial services, like instant petty loan, which can meet farmers' urgent needs. In fact, Chinese financial system is far from perfection (Zhang, 2019). It is very troublesome for farmers to borrow money from banks, which requires various approvals, cumbersome procedures, equivalent collateral, long waiting time, and so on (Wen *et al.*, 2016). Hence, simple and instant micro finance services could bring great convenience to the farmers who need money urgently, helping farmers get out of rut. Thirdly, RESC can also become a social gathering place for local farmers (Cai *et al.*, 2019). RESC can work as a social platform, where farmers can communicate with more other farmers and learn more new things (Jin, 2019). Social activities help to improve farmers' spiritual satisfaction, thus positively affecting their SWB (Li and Chen, 2012).

To sum up, the services of RESC bring much convenience to local farmers, thus may improve their SWB. However, in the development process of the RESC project, there was once a time that quantity explosion and quality decline made it difficult for the RESC to provide the villagers reliable and high-quality services. Thus, RESC may not be able to effectively improve the SWB of farmers. The final effect needs a test to reach the conclusion.

3. Methods and materials

3.1 Method

Our aim is to identify the impact of RESC on farmers' SWB. For doing so, we divide the samples into two groups: (1) treated group, which includes the farmers who have accepted the agent sale, purchase and payment service from RESC; and (2) control group, which includes the farmers who have not accepted any service from RESC. We specify an econometric model to study the relation between RESC and farmers' SWB:

$$Y_i = \delta_0 + \delta_i D_i + f(X_i) + \mu_i \quad (1)$$

Where i denotes farmer, Y is the SWB, D is binary variable of whether farmers have accepted the services provided by RESC, X is the control variable vector, δ_0 is a constant term, μ is stochastic disturbance term. If the farmers are randomly assigned to the treated group or control group, δ_0 can accurately estimate the net effect of RESC on farmers' SWB. However, it is not random for farmers to decide whether to accept the service from the RESC. The farmers' decision-making may be affected by some unobservable factors, while these factors are related to the dependent variable (Y). And that will lead to self-selection bias, if we estimate Equation 1 directly without considering the unobservable factors. ITo address the self-selection bias, we decide to use the propensity score matching (PSM) method which has been widely used in relevant research (Heckman and Vytlacil, 2007; Kassie *et al.*, 2011; Li, 2014; Mendola, 2007).

According to the framework of PSM method and the definition of Rosenbaum and Rubin (1983), the average treatment effect of the treated group (ATT) is defined as:

$$ATT = E(Y_1 \mid D{=}1) - E(Y_0 \mid D{=}1) = E(Y_1 - Y_0 \mid D{=}1) \quad (2)$$

Where Y_1 is the SWB of farmers when they accept the services of RESC, Y_0 is the SWB of farmers when they do not accept the services. In order to eliminate the disturbance of other factors, ATT limits the research sample to accept services (D=1), and calculate the difference of SWB in the treated group under the conditions of accepting and not accepting services, that is, the net effect of RESC on farmers' SWB. As Winship and Morgan's study (1999) shows, when evaluating the effectiveness of a project, it is not whether the project is beneficial to all individuals, but whether it is beneficial to the individuals who participate in the project and accept the relevant service. In Equation 2, the result of $E(Y_1 \mid D{=}1)$ can be observed, while the result of $E(Y_0 \mid D{=}1)$ is unobservable which is called counterfactual result. But the result of $E(Y_0 \mid D{=}1)$ can be substituted by an index which is constructed by PSM.

The general idea of PSM to eliminate self-selection bias is to select or construct an control sample for each sample in the treated group from the control group, and ensure that the characteristics of the two samples are almost the same, except for the difference in accepting RESC services. Therefore, the result of the two samples can be regarded as the results of two different experiments of the same sample (accepting and not accepting the services of RESC), while the difference of the two samples' results is the net effect of accepting the services.

To achieve this goal, we first calculate the conditional probability of service acceptance of samples i, $p_i = P(D_i=1|X_i)$, which is called propensity score (PS), under the condition of given matching variable X. Secondly, we select a sample that do not receive RESC services and have PS to match each sample in the treated group, so as to construct a statistical control group. Actually, this matching model constructs a random experiment, which makes the treated group and the control group can be compared directly, and satisfies the following two hypotheses: (1) given the PS and matching variable X, D and Y are independent with each other; (2) given the matching variable X, $0<p_i<1$ holds, which is called the common support condition. The common support condition removes the tail data of PS distribution, while the less data is removed, the more reliable the matching result is.

As is known to all, there are many matching methods that can be used for matching, but these methods have different trade-offs for deviation, resulting in different matching results (Caliendo and Kopeinig, 2008). In order to ensure the robustness of matching results, many methods (such as k-nearest neighbor matching method, kernel matching method, radius matching method, etc.) are generally used to match at the same time in empirical analysis.

Based on the work of Chen and Zhai (2015), we define the net effect of RESC on farmers' SWB as Equation 3. In Equation 3, I_i is the sample set of the treated group, y_{1i} is the SWB value of the treated group, I_0 is the control sample set, y_{0k} is the SWB value of the control sample matched with farmer i, S is the common support domain, N is the number of samples in the treated group, w is the weight, and the weight $w(i,k)$ depends on the different matching method.

$$ATT = \frac{1}{N} \sum_{i \in I_i \cap S} [y_{1i} - \sum_{k \in I_0} w(i,k) y_{0k}] \quad (3)$$

In addition, sensitivity analysis is often used after PSM to check if there are any important missing variables having been ignoredin the empirical analysis. The principle of sensitivity analysis is to assume that there are one or more unknown missing variables. And if the substantial changes of these missing variables do not make any differences, the results can be regarded to be reliable. Among various sensitivity analysis methods, the Rosenbaum Bounds method is widely used. Here, we use gamma coefficient (Γ) to describe the impact of unobservable missing variables on whether farmers accept the RESC services. The key of the method is to observe the level of gamma coefficient (Γ) which makes the empirical results not significant any more. If the empirical result is not significant when Γ is close to 1, it means that the PSM result is not robust. If the empirical result is not significant when the value of Γ is large enough ($\Gamma \geq 2$), it can be considered that the PSM result is robust (Rosenbaum and Rubin, 1983).

3.2 Data source

The data was collected via a questionnaire investigation from farmers in Tonglu County, Zhejiang Province from April to June 2017. Tonglu County, as the first pilot city of Alibaba's RESC Project, is the first county to realize the full coverage of RTSC in China. The questionnaire investigation strictly follows the procedure of 'design, pre-survey, questionnaire modification, formal survey'. Only when the questionnaire can be understood and accepted by the interviewees can the questionnaire be carried out. We use the two-step sampling method in self-service method to select samples: in the first step, we divided 14 towns into three levels according to the economic development level of each town in Tonglu County, and selected 9 of them including Jiuxian Town, Fuchunjiang Town, Hengcun Town, Fenshui Town, Yaolin Town, Jiangnan Town,

Zhongshan Town, Hecun Town, and Heshan Town; in the second step, we selected 2 villages of each town by using the random sampling method, then selected farmers in the villages by chance sampling. We issued 20 questionnaires for each village, totaling 360 questionnaires. Finally, 345 of them were valid and the effective rate was 95.8%.

3.3 Description of variables

The dependent variable in this study is SWB of farmers (Table 1). SWB is individual's self-evaluation of the quality of life, which reflects the quality of material life and the psychological satisfaction. It can judge someone's overall satisfaction with life more completely and reasonably (Bian and Xiao, 2014; Frey and Stutzer, 2002; Gautam and Andersen, 2016). There are many methods to measure individual's SWB, among which self-report scale is the most commonly used. The self-report scale directly asks people about their happiness, which is generally set the question as 'Do you feel very happy, a little unhappy, average, not very happy, or very unhappy?' Easterlin (2003) suggested that the data produced by the self-report scale method had high reliability, validity and comparability. Therefore, we set the questions according to the above method, and use the numerical value of 1-5 to represent very unhappy, a little unhappy, average, relatively happy and very happy.

The statistical results in Table 1 show that the average SWB of the selected farmers is 3.70, which means that they are generally happy and satisfied with life. The average SWB of the farmers in treated group is 0.509 units higher than that in control group, while the statistical difference is significant. This result shows that

Table 1. The statistical description of variables.[1]

Variables	Definition of variables	Mean of treated group (A)	Mean of control group (B)	Difference (A-B)
Subjective well-being	1 = very unhappy; 2 = a little unhappy; 3 = average; 4 = relative happy; 5 = very happy	4.01	3.50	0.51***
Gender	0 = female; 1 = male	0.70	0.62	0.08*
Age	Actual age	59.08	62.66	-3.58***
Age^2	Square of actual age	3,602.20	4020.32	-418.12***
Farming years	Actual farming years	37.38	43.54	-6.16***
Education	1 = primary school and below; 2 = middle school; 3 = high school; 4 = bachelor degree or higher	1.74	1.35	0.39***
Marriage	0 = unmarried; 1 = married	0.96	0.99	-0.03**
Political status	Are you a member of the Communist Party of China? 0 = no; 1 = yes	0.32	0.24	0.08
Neighborhood	Is your neighbor trustworthy? 1 = very untrusted; 2 = a little untrusted; 3 = average; 4 = a little trusted; 5 = very trusted	4.13	4.27	-0.13
Pension	Do you have endowment insurance? 0 = no; 1 = yes	0.40	0.32	0.08
Farmer number	Number of farmers in the family	1.37	1.37	0.00
Property rights of land	Do you have the land contract management certificate? 0 = no; 1 = yes	0.70	0.73	-0.03
Housing area	The size of housing area (m^2)	94.29	96.84	-2.55
Per income of family	Per income of family: 1 = <10,000; 2 = 10,000-15,000; 3 = 15,000-20,000; 4 = 20,000-30,000; 5 = >30,000 (yuan)	2.93	2.76	0.17

[1] The fifth column is the result of *t*-test; ***, **, * means 1, 5, 10% significance level, respectively.

the SWB of the farmers who have accepted RESC services is higher. However, whether to accept the RESC services is the 'self-selection' behavior of farmers. This statistical difference may not be the inevitable result of farmers accepting the services, but caused by other factors. We need to be cautious about the statistical results in Table 1 and test the impact of RESC on the SWB of farmers by causal analysis. The statistical description of other variables is also shown in Table 1.

4. Results

4.1 Results of linear regression

Table 2 presents the multiple linear regression results with SWB as the dependent variable, while column 2 is the result obtained by progressive regression. It finds that the RESC services have a significantly positive effect on farmers' SWB both in columns 1 and 2. Specifically, the result in column 1 shows that the SWB of farmers who have received RESC services are about 0.497 unit higher than that of those who have not received. While the column 1 presents a similar result, 0.489, although this model reduces many control variables. It is suggested that RESC services could improve the SWB of farmers and this result is steady and robust. But we still need to be cautious about this result. Although the two models fit well and the variable of RESC services is significant at the level of 0.1%, the results need to be treated cautiously due to the self-selection bias.

The SWB of farmers is negatively affected by age while positively affected by the square of age. It shows that the relationship between farmers' age and their SWB is U-shaped, namely the SWB of farmers decreases in the first stage and then increases with the increase of age. Middle-aged farmers need to support the elderly and raise children, which makes them bear more responsibilities and pressure, so their SWB is lower than the elderly farmers and young farmers.

Table 2. The results of multiple linear regression.[1]

	1	2
RESC services	0.497*** (0.099)	0.489*** (0.095)
Gender	0.052 (0.099)	
Age	-0.121*** (0.044)	-0.116*** (0.039)
Age^2	0.001*** (0.001)	0.001*** (0.003)
Farming years	-0.001 (0.006)	
Education	0.033 (0.079)	
Marriage	0.388 (0.374)	
Political status	0.284*** (0.110)	0.309*** (0.104)
Neighborhood	0.073 (0.056)	
Pension	-0.0453 (0.099)	
Farmer number	0.153* (0.078)	0.151** (0.077)
Property rights of land	-0.019 (0.107)	
Housing area	0.004** (0.002)	0.004** (0.002)
Per income of family	0.122*** (0.038)	0.130*** (0.037)
Constant	5.048*** (1.326)	5.628*** (1.182)
R-squared	0.2109	0.2020
F	5.48***	12.19***
Number of observations	345	345

[1] ***, **, * means 1, 5, 10% significance level, respectively; RESC = rural e-commerce service centers; standard errors are reported in parentheses.

Political status, as expressed by whether the farmer is a member of the Communist Party of China, is positively correlated with the SWB. In China, the requirements for joining the Communist Party are very strict. The farmers who have joined the Communist Party of China tend to have a wide range of social intercourse and good popularity, which enables them to enjoy more spiritual pleasure and thus have a stronger sense of SWB.

Housing area and per income of family are positively associated with the dependent variable. The larger the housing area is, the more spacious the living space is for the farmers; the higher the per capita income is, the better the material life is for the farmers. The comfortable and prosperous life makes the farmers have a stronger sense of SWB.

Farmer number, as expressed by the number of the family member who do farming, is positively correlated with the dependent variable. With the growth of economy and the expansion of the gap between urban and rural development in China, more and more rural young and middle-aged individuals give up farming and go to work in cities, leading to the increasingly serious phenomenon of 'empty nest elderly' and 'left over children' in rural areas and negatively affecting the SWB of rural residents. More farmers in the family members means that more family members stay in the rural areas, which enables them to enjoy more spiritual pleasure.

4.2 Results of propensity score matching

■ *Propensity score and common support*

The first step of PSM analysis is to estimate the decision-making equation of farmers' acceptance of RESC services, so as to obtain the PS of farmers' choosing to accept the services. There will be overlap in the PS range between the treated group and the control group, which is called 'common support'. If the common support is too narrow, it means that there is a great possibility of sample loss in the matching process. As Figure 3A and Figure 3B show, the PS of treated group and control group overlap in a large range. Then we find that the PS interval of accepted group is [0.166, 0.992], the PS interval of control group is [0.057, 0.777], thus the common support is [0.166, 0.777]. In addition, the maximum loss samples of the treated group are 9, which is far lower than the total samples used. Finally, the common support area is acceptable.

■ *Samples matching and the matching quality test*

The main purpose of using PSM is to balance the distribution of matching variables between the treated group and the control group. Therefore, after the matching, we need to test the statistical significance of matching variables between the two groups, that is, to test the balance of matching variables. As the results of the balance test in Table 3, we find that the standardized bias of the matching variables is reduced from

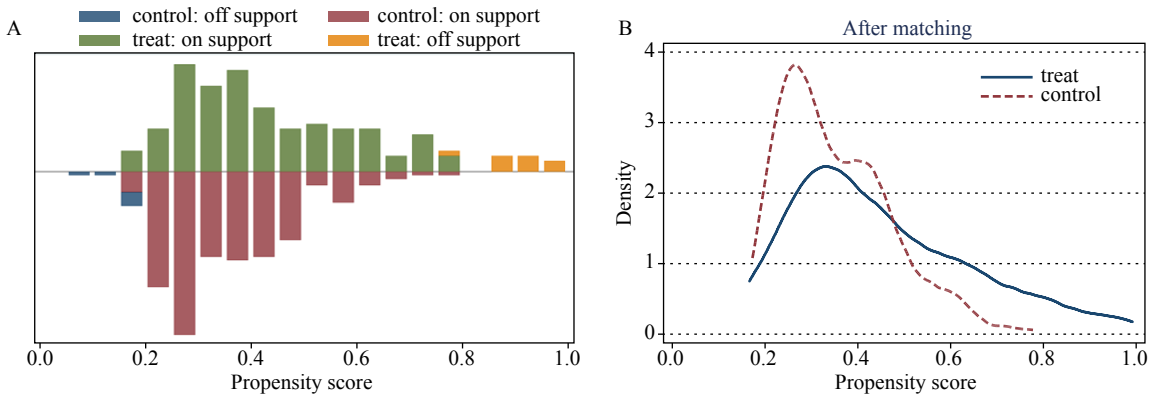

Figure 3. Common support and density of propensity score.

Table 3. The balance test of matching variables before and after propensity score matching.

	Pseudo-R^2	Likelihood-ratio (*P*-value)	Bias (%)
Before matching	0.085	39.58 (0.001)	21.5
Nearest neighbor matching (1-5)	0.018	6.32 (0.974)	6.0
Nearest neighbor matching (1-10)	0.011	3.80 (0.998)	3.8
Radius matching (r=0.005)	0.003	0.90 (1.000)	2.6
Radius matching (r=0.010)	0.006	1.95 (1.000)	3.4
Kernel matching (width=0.01)	0.006	2.02 (1.000)	2.9
Kernel matching (width =0.10)	0.019	6.76 (0.964)	6.1

21.5 to 2.6-6.1% after matching, which means that the total bias is greatly reduced and the data balance is greatly improved. The *P*-value of Likelihood-ratio statistics shows that the joint significance test of matching variables is statistically significant before matching and becomes almost insignificant after matching. While the value of Pseudo-R^2 decreased from 0.085 before matching to 0.003-0.019 after matching. The results above show that propensity score estimation and sample matching are successful, in terms of balancing the matching variables between the two groups of samples.

■ *The result of rural e-commerce service centers affecting farmers' subjective well-being*

Table 4 presents the net effect of RESC on farmers' SWB by three methods, namely nearest neighbor matching, radius matching, kernel matching. The results from different methods are used as robustness tests. The results show that the quantitative values obtained by different matching methods are slightly different, but the SWB effect values are all positive and significant at the level of 1%. It means that the agent purchase, sales and payment services of RESC provide convenience and welfare for farmers and make them feel happier. Specifically, the net effects of RESC on farmers' SWB in different situations are 0.549, 0.498, 0.591, 0.545, 0.539, and 0.491, respectively. And the average net effect is 0.536. It means that the SWB of the farmers who have received RESC services are about 0.536 unit higher than that of those who have not received.

Comparing the results in Tables 2 and 4, we can see that the results of PSM are more reliable. Due to possible disturbance variables, we use PSM to separate the acceptance of RESC services from other factors that affect the SWB of farmers, so as to investigate the net effect of its impact on the SWB of farmers. The average net effect of PSM is 0.536, higher than that of liner regression. It indicates that the result of PSM are more reliable than the regression result which is an underestimation.

Table 4. The net effect of rural e-commerce service centers on farmers' subjective well-being.[1]

Matching method	Parameters	Effect of RESC on farmers' SWB (ATT)
Nearest neighbor matching	1-5	0.549***
	1-10	0.498***
Radius matching	r=0.005	0.591***
	r=0.010	0.545***
Kernel matching	width=0.01	0.539***
	width=0.10	0.491***

[1] ***, 1% significance level; ATT = average treatment effect of the treated group; RESC = rural e-commerce service centers; SWB = subjective well-being.

■ *Sensitivity analysis by the Rosenbaum Bounds method*

Since PSM is sensitive to the conditional independence hypothesis, it is necessary to investigate whether there are potential biases that affect both the outcome variable and the processing groups (Bi and Ma, 2012). However, it's difficult to measure the potential bias directly. Therefore, we can evaluate the sensitivity of unobservable factors to the treatment effect through Rosenbaum Bounds method (Rosenbaum, 2002).

Table 5 presents the results of sensitivity analysis by Rosenbaum Bounds method. As the result of the second line shows, when the measurement index of potential bias is Γ=1, namely there is no unobservable factor, the sign rank test is significant at the level of 0.1%, and Hodges Lehmann estimate (0.5) is close to the matching result, indicating that the acceptance of RESC services has a significant treatment effect on farmers' SWB. The results in columns 1 to 3 show that the upper bound of significance level decreases with the increase of Γ. When the Γ reach 2.2, it means that the occurrence ratio of matched individuals with the same observation variable value is 2.2 times because of the potential biases and the Sig^+ is more than 5%. According to Rosenbaum and Rubin (1983), if the result sensitivity analysis is not significant until the value of Γ is close to 2, it can be considered that the empirical results of PSM are reliable. Therefore, we have a good reason to believe that the PSM results in Table 4 are reliable.

From the comparison of existing literature and this paper, this result could fill in current research gap. It has been considered that rural e-commerce is helpful to promote the income and consumption of farmers (Zeng *et al.*, 2015, 2018), to attract more migrant workers and college graduates to back hometown (Cai *et al.*, 2019; Cui *et al.*, 2014), and to improve the rural urbanization and infrastructure (Fang, 2016). While these factors, like income and consumption, are important factors that affect the SWB of farmers (Bai, 2015; Li and Wang, 2015; Liao, 2014; Shen *et al.*, 2014; Wang, 2010). Although the existing literature did not study the impact of rural e-commerce from a more comprehensive and thorough perspective, the effects of those factors will ultimately be reflected in the SWB of farmers. Hence, we devote to carry out this research and find that the average net effects of RESC on farmers' SWB is 0.536, which is steady and robust. It provides empirical evidence for the previous theoretical analysis.

5. Concluding remarks

This paper introduces the development process and service content of RESC and empirically analyzes the influence of RESC on farmers' SWB with the methods of PSM based on the investigation data of 345 farmers collected from Tonglu County, Zhejiang Province. From the perspective of SWB, this paper provides empirical evidence for the cooperation between local governments and e-commerce enterprises in the field of RESC. Actually, RESC is a beneficial practice for local governments to utilize the internet to improve farmers' welfare and it has a positive exemplary significance for 'internet plus rural public services'.

Table 5. The results of sensitivity analysis by the Rosenbaum Bounds method (matching number=125).[1]

Gamma (Γ)	Sig^+	Sig^-	t-hat^+	t-hat^-	CI^+	CI^-
1.0	1.9 E-07	1.9 E-07	0.50	0.50	0.40	0.70
1.2	1.3 E-05	1.1 E-09	0.45	0.60	0.30	0.80
1.4	2.3 E-04	5.7 E-012	0.45	0.65	0.20	0.90
1.6	0.00179	2.8 E-014	0.40	0.75	0.10	0.95
1.8	0.00819	1.1 E-016	0.30	0.80	0.05	0.95
2.0	0.02561	0	0.25	0.85	-4.8 E-07	1.00
2.2	0.06099	0	0.20	0.90	-0.05	1.05

[1] Gamma = the logarithmic occurrence ratio of different arrangements due to unobserved factors; Sig^+ = upper bound of significance level; Sig^- = lower bound of significance level; t-hat^+ = upper bound of Hodges Lehmann point estimation; t-hat^- = lower bound of Hodges Lehmann point estimation; CI^+ = upper bound of confidence interval (0.95); CI^- = lower bound of confidence interval (0.95).

The results show that e-commerce and RESC can effectively improve the SWB of rural residents because of the services provided by RESC, which has been verified in some areas. By the end of May 2015, there has been 183 villages all over Tonglu County establishing RESC. In June 2015, the 183 RESC purchased 25,247 online orders for local farmers, totaling 5.28 million yuan[6]. From the data above, the RESC have brought great convenience for farmers' consumption in Tonglu County. By the end of 2016, the amounts of e-commerce sales have reached 5.006 billion yuan, while the cross-border e-commerce of exports and imports have come up to 104 million and 20.33 million US dollars, respectively[7]. Therefore, RESC have opened up the market of agricultural products and the consumption channels, and brought much convenience to the farmers in Tonglu, which may improve their SWB. With the development of rural e-commerce in China, farmers in more areas are expected to benefit from RESC in the near future.

However, there are many problems with RESC. Firstly, due to the differences in professional level and management ability of RESC managers, the service quality varies in different RESC. Secondly, the income increasing effect is limited for the RESC managers, which may seriously weaken their operating enthusiasm. In fact, RESC have the complex natures of both public services and marketization. Hence, the managers need to provide relevant services, but it is difficult to get real benefits or profits, which may put them in a dilemma. Thirdly, the competition among e-commerce companies is very fierce, resulting in repeated distribution. A village may have more than two RESC supported by different companies, which will lead to higher costs and lower efficiency.

Therefore, local governments should take some actions to solve these problems, so that the RESC can operate sustainably and efficiently. They need to strengthen policies on introducing or cultivating professionals of rural e-commerce, and constantly improve the service quality of RESC in the future, so as to make the e-commerce play a better role in serving farmers. Firstly, local governments should cooperate with e-commerce enterprises to reasonably allocate RESC distribution points, preventing vicious competition and unnecessary loss of efficiency. Secondly, local governments and e-commerce enterprises should provide appropriate subsidies and high-qualityskills training to enhance the confidence and professional skills of RESC managers. Thirdly, e-commerce enterprises should develop a new revenue flow mode for RESC so that creates more profit margins for the managers.

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