Will participating in ECPs improve organic tea farmers’ income in the context of the COVID-19 epidemic?

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Abstract Product commercialization is an integral part of the production chain. Previously, most farming households sold organic tea to traders, supermarkets, and consumers at traditional markets. However, in the context of the complicated development of the COVID-19 epidemic, they have gradually switched to selling online or on e-commerce platforms (ECPs). The benefits of ECPs to the community’s health have been demonstrated in many studies. However, the economic benefits for organic tea farmers have not been specifically considered. This study aims to shed light on whether participating in ECPs improves the income of organic tea farmers in the context of the COVID-19 epidemic. To answer this question, we used the Propensity Score Matching (PSM) method after interviewing 298 organic tea farmers in the mountainous provinces of northern Vietnam. Research results have shown that farming households that use ECPs to sell products have a higher income than those that do not use ECPs. This result implies that supporting and promoting farmers to put organic tea on ECPs is a valuable solution to help them improve their income. Therefore, local authorities and farmers’ associations in the mountainous provinces of northern Vietnam should find practical solutions to support farmers’ participation in ECPs during the current epidemic.

Keywords E-commerce platform · Organic tea farmers · Income · Vietnam · COVID-19

Introduction

The SARS-CoV-2, also known as coronavirus 2019 (COVID-19), is considered one of the deadliest epidemics of the past hundred years (Kumar et al., 2021). The emergence of the epidemic has created many significant fluctuations from the micro- to the macro-levels. Around the world, trade and services in many countries have been delayed for a long time. Due to social distancing, dozens of companies have gone bankrupt, and most smallholder farmers have to adapt to changes in production and business methods due to social distancing. Although Vietnam is known as one of the few countries that successfully contained the COVID-19 epidemic (Nguyen et al., 2021a, b), the negative impact of the epidemic on business activities is sizable, especially in vulnerable economic sectors such as farming households.
Since the complicated outbreak of the disease in early 2020, the Vietnamese government and local authorities have implemented several social distancing regulations to limit the spread of the disease. These measures have significantly changed consumer behavior. According to data from the E-commerce White Paper, in 2020, Vietnam had the highest percentage of people shopping through e-commerce in Southeast Asia, with about 49.3 million people (Vietnam e-commerce and digital economy agency, 2021). In a study on e-shopping in Ha Noi, Nguyen et al. (2021a, b) showed that up to 80% of the participants in their study chose ECP shopping more since the epidemic appeared. This shift stems from the fear of illness and the need to follow social distancing regulations. Consumer behavior changes make companies, restaurants, shops, and farmers change their selling strategies and methods.

In large urban areas in Vietnam, switching to online sales is relatively easy for restaurants, shops, supermarkets, or small businesses. However, such switching can be a big challenge in rural areas, especially for farmers in the mountainous provinces of northern Vietnam. Farmers often prefer traditional methods over new ones (Dung, 2018). Farmers in this area often lack knowledge and experience in online sales and do not understand how to use ECPs. In addition, the technology infrastructure in some mountainous areas is still poor (The World Bank, 2016). In addition, organic products often cost more than traditional products (Mkhize and Ellis, 2020; Nafees et al., 2022), which narrows the customer base. These things make farmers hesitant to approach new selling methods because they are worried about the risks and costs incurred when participating in ECPs.

From a medical point of view, participating in ECPs can help farmers limit the risk of disease transmission due to direct contact. Moreover, when participating in ECPs, farmers can reach many customers everywhere, which helps them maintain sales during the epidemic and even in the future. Based on the Random Utility Model, the farmer will adopt a new technology only if the expected value of the benefits from adoption exceeds the expected value from current practices. Our survey in in four mountainous provinces of northern Vietnam revealed that 102 households participate in ECPs with outstanding Vietgap and organic products such as dried tea, fragrant zucchini, rice, Han Yen oranges, and flexible pumpkins. This figure shows that some farmers have realized the importance of ECPs for sales and the benefits that ECPs bring.

Against this background, this study aims to shed light on whether participating in ECPs improves the income of organic tea farmers in the context the COVID-19 epidemic. In doing so, we used the PSM to compare the income of organic tea farmers participating in ECPs and those not participating in ECPs. Besides, we employed a balancing hypothesis test, common support assumption test, and other matching methods to ensure the efficiency of the results. The remainder of this manuscript is as follows. The “Literature review” section elaborates on the benefits and costs of participating in ECPs. The “Methodology” section details the methods used to perform the empirical analysis. Data collection and measurement of variables are presented in the “Data sources and measurement” section. The “Empirical results” section reports the empirical findings. Discussions and theoretical and managerial implications are provided in the “Discussion” section. Finally, the “Conclusion” section concludes.

Literature review

Theoretically, the decision to participate in ECPs or not entirely depends on farmers’ analysis of the benefits and costs of this selling method. If the benefits outweigh the costs of participating in ECPs, farmers will switch to selling through ECPs. On the contrary, if the benefits of participating in ECPs are lower than the costs, they will maintain the traditional method of selling (direct selling). Compared to the traditional selling method, selling through ECPs has some outstanding advantages, but it also has some disadvantages. From a theoretical point of view, it is difficult to say whether participating in ECPs will bring higher income to farmers. Therefore, this section will analyze the economic opportunities and challenges of selling through ECPs compared to direct selling. In the context of the COVID-19 epidemic, just like supermarkets and shops, tea farms and households have also begun to choose to sell on ECPs. Despite some initial difficulties associated with selling online, most business owners consider this selling method a “lifeline” for their economic prospects (Hien, 2021).

In the epidemic context, participating in ECPs can bring economic and non-economic benefits to farmers (the sellers). In terms of non-economic benefits, participating in ECPs will minimize direct interaction
between buyers and sellers, reducing disease transmission. Regarding economic benefits, selling products through ECPs helps farmers access more customers and increase the number of goods sold (Peng et al., 2021; Zheng, 2009). If in the past, most farmers mainly sold organic tea to traders, supermarkets, or retail customers at local traditional markets, now they can reach many customers in other parts of the country. Thanks to the valuable features of ECP, farmers can choose to display products according to the geographical location and the preferences and tastes of customers, making it easy for them to connect with potential customers (Zheng, 2009). In addition, participating in ECPs helps tea farmers save many costs in marketing and transportation, thanks to policies to reduce shipping fees in some applications (Shaltoni, 2016). Zhu et al. (2021) tested the quality and safety of e-commerce agricultural products based on 5G Internet of Things technology and showed that sellers could monitor and control shipping information for each order. Information about the process of transporting goods is regularly updated on the system, which helps both buyers and sellers manage goods efficiently. In addition, the platform also offers many opportunities for sellers through the integration of diverse payment methods (Zheng, 2009). When making transactions on e-commerce platforms, sellers and customers can choose different payment methods to suit their needs. For fresh and clean agricultural products, farmers can request payment or deposit via credit card first and then send the order, reducing the risk in case the customer does not want to receive the goods or wants to return the goods to the seller.

However, participating in ECPs may bring some challenges to organic tea farmers, especially those who live in mountainous areas. First, farmers may face risks when transacting online. On social networks, there have been many cases where buyers “bomb goods,” meaning that the buyer places an order, but when the goods arrive, he or she does not answer the phone and receive the goods (Thanh, 2020). In this case, the seller will bear a loss due to paying the shipping fee twice to the delivery company. In particular, the seller must bear the costs of shipping the goods to the buyer and returning the goods to the seller. In addition, farmers also face the risk of credit card transactions (Dhanapal et al., 2015). Second, organic tea products face fiercer competition when sold through ECPs compared with direct sales. The fundamental reason is that consumers have many more choices when shopping online, and they often compare items of the same type before deciding to buy (Lohr et al., 2011). In this case, the advantages of organic tea over traditional tea are not visible to the buyer. Consumers can only judge products by sight and price when shopping online, but not by physical experiences such as touching, smelling, and tasting (Peng et al., 2021).

Meanwhile, the disadvantages of organic tea are apparent to consumers. Namely, like other organic agricultural products (Mkhize and Ellis, 2020; Nafees et al., 2022), organic tea costs more than traditional tea. In addition, organic products often have an unattractive appearance compared to traditional products. Higher prices and poorer appearance create barriers for farmers to get their products on ECPs and reach customers, especially customers who only buy organic products occasionally (Aschemann-Witzel & Zielke, 2017; Robina-Ramírez et al., 2020).

It is not difficult to see the benefits of selling on ECPs for farmers, but the risks are not zero. Therefore, whether the benefits outweigh the risks of selling via ECPs is still ambiguous. Currently, the Vietnamese government has opened an ECP for agricultural products to help farmers adapt to the epidemic. However, the number of households deciding to participate in ECPs is low because they are still vague about their benefits, especially farmers in mountainous areas.

Many scientists have explained the intention to use online applications, an area that includes ECPs. Robina-Ramírez et al. (2020) used interview data from 106 organic product manufacturers in Spain’s largest electronic market to study the intention to join the online platform. Their empirical results show that perceived economic and non-economic benefits, ethics and fair trade, the attitude of use, and ease of use are the causes for adopting e-marketplace intentions. The attitude of use (which describes an attitude, experience of online shopping, and assessment of customer experience) is the factor that has the most substantial impact on the intention to use that online platform. Wang et al. (2003), Michels et al. (2019), and Van et al. (2022) indicated that perceived usefulness and perceived ease of use of online applications have a positive impact on the users’ behavior of using applications (e.g., internet banking, ECPs) on
smartphones. Among them, Michels et al. (2019) suggested that people with smartphone experience will be more likely to form an intention to use smartphone applications. This finding is consistent with Rose et al. (2016), who indicated that young farmers tend to adopt smartphone applications more because they have more experience with digital technologies. From another perspective, it is pointed out that support from the government plays an essential role in motivating farmers to engage with ECPs. This support is not only about introducing technology to farmers but also helps farmers gain more knowledge, eliminating geographical distances (Landmann et al., 2020). In short, users’ intention to use smart applications can come from the perception of economic and non-economic benefits, the experience of use, and support from the government and experts.

Methodology

Conceptual framework

Most farmers’ voluntary decisions depend on several factors that can lead to self-selection bias (Danso-Abbeam et al., 2020). In this study, the organic tea farmers’ decisions to participate in ECPs may depend on access to knowledge, information, and support resources. In addition, farming households participating in ECPs (participating group) and those not participating in ECPs (non-participating group) have different characteristics such as gender, age, education level, and culture. All these factors affect the income of organic tea farmers. Therefore, they can lead to biased estimates of the impact of participating in ECPs on farming households’ income. Therefore, following Doanh et al. (2018), the decision of farmers to participate in ECPs must be random. That means the characteristics of the two above groups must be the same, and income is the only difference between the two groups.

We assume that the income of the farming household in the participating group is $Y_1$ and the income of the farming household in the non-participating group is $Y_0$. The impact of participating in ECPs on farming households’ income can be described by the difference between the income of those in the participating group and those in the non-participating group, as follows:

$$\Delta Y = Y_1 - Y_0$$  \hspace{1cm} (1)

$\Delta Y$ can accurately reflect the impact of participating in ECPs on the income of a farming household if the household is in both participating and non-participating groups. However, a farming household can only join one of the two groups at a time. Therefore, it is impossible to simultaneously measure both $Y_1$ and $Y_0$ of a farming household. To overcome this limitation, Olounlade et al. (2020) recommend using the average treatment effect on the treated (ATET). The ATET is expressed in the following mathematical formula:

$$\Delta Y_{ATET} = E(Y_1|T=1) - E(Y_0|T=0)$$  \hspace{1cm} (2)

where $T=1$ if a farming household is in the participating group and $T=0$ if a farming household is in the non-participating group.

Propensity score matching

To estimate ATET, we first use the PSM. The PSM operates through two main steps (Ayuya, 2018; Danso-Abbeam et al., 2020). First, the propensity scores are determined based on the logit model with the dependent variable $T$ as follows:

$$P(X) = \Pr [D = 1/X] = E[D/X]; p(X) = \Phi(X)$$

$$p(X) = \Pr (p = 1/X)$$  \hspace{1cm} (3)

in which $\Phi$ can be normal or logistic. $X_i$ is a set of observable covariates.

Second, after propensity scores are estimated, we calculate ATET. However, propensity score matching is effective and not biased if the two following assumptions are satisfied: (1) The conditional independence assumption in observational data states that treatment assignment is as good as random after conditioning on the covariates. Algebraically, this can be presented as $(Y_i^1, Y_i^0) \perp T_i|X_i$. (2) The common support assumption implies that the probability of receiving treatment for each possible value of the vector $X_i$ is strictly within the unit interval, $0 < P(T_i = 1|X_i) < 1$.

Based on these two above assumptions, the propensity score matching estimator for ATET can be presented through the following formula:
Up to now, there are three commonly used matching methods: Nearest-Neighbor Matching (NN), Capiler with Radius Matching (Capiler), and Kernel Matching (Kernel). To ensure the robustness of the results, following Doanh et al. (2018) and Budhathoki & Bhatta (2016), we employ all three matching methods, including NN (NN-1 and NN-5), Kernel, and Capiler with a Radius of 0.05. Several metrics are worth considering to compare the effectiveness of methods before estimating ATET. Becerril and Abdulai (2010) suggest comparing pseudo-$R^2$’s before and after matching to see how well the regressors explain the adoption probability. After matching, pseudo-$R^2$ should be close to zero, indicating no systematic differences between the treated and control groups.

**Data sources and measurement**

**Sample and data collection process**

We collected primary data from 298 farming households randomly selected from four localities in the mountainous provinces of northern Vietnam, including Thai Nguyen, Tuyen Quang, Yen Bai, and Bac Kan provinces (see Fig. 1). We chose these four provinces because they are known for their clean products, including organic tea. In addition, the coverage of telecommunications networks, the internet, and the number of people using smart devices such as smartphones and computers all account for a high percentage of the total population. Due to the context of the COVID-19 epidemic and social distancing regulations, we hired investigators from other localities in the province to collect data. All participants were briefed on the main purpose of this study and asked to sign a written consent form. After finishing the investigations, we collected 298 out of 600 questionnaires. There were 302 unqualified questionnaires because (1) the respondents did not provide enough information (199 questionnaires) and (2) The respondents only chose one answer (103 questionnaires). The response rate is 48.83%.

**Measurement**

Following Doanh et al. (2018), regarding the outcome variable, the income of organic tea farmers is represented by the average income from selling...
organic tea per month. Based on the literature review, this study used basic factors affecting treatment variables, including control variables (age, gender, culture, and education), access to the internet, access to the telecommunications network, perceived economic benefits, perceived non-economic benefits, experience in selling online, using smartphones, and using internet banking.\(^1\) Detailed information about the definition and measurement of variables is presented in Table 1.

\(^1\) In addition to the online sales function, ECPs also integrate online payment functions. Therefore, besides the experience of selling online using the smartphone, we also mention the experience of using internet banking.

### Empirical results

#### Demographic characteristics

The summary of statistics for the participating and non-participating groups is displayed in Table 2. The percentage of farmers participating in ECPs to sell organic tea is still low (36.58%). The results in the statistics table show that there is a significant difference in age, education, and income between farmers in the participating and non-participating groups, in which the majority of farmers in the participating group are young. The education level of farmers in this group is about 0.9 years higher than that of the non-participating group. In addition, the test results show no significant

| Variables | Definition and measurement |
|-----------|-----------------------------|
| **Outcome variable** |  |
| Income | The farming household's net income per ha per month, USD |
| **Treatment variable** |  |
| Participating in ECPs | Dummy variable that takes the value of 1 if the farming household head has participated in the e-commercial market, and zero otherwise |
| **Observable covariates** |  |
| Age | Age of the farming household head, measured in years |
| Gender | Dummy variable that takes the value of 1 if the farming household head is male, and zero otherwise |
| Culture | Dummy variable that takes the value of 1 if the farming household head belongs to the ethnic Kinh group, and zero otherwise |
| Education | Educational level of the farming household head, measured in the number of years of schooling |
| Internet | Dummy variable that takes the value of 1 if the farming household head has access to the internet, and zero otherwise |
| Telecommunications network | Dummy variable that takes the value of 1 if the farming household head has access to the telecommunications network, and zero otherwise |
| Economic benefits | Dummy variable that takes the value of 1 if the farming household believe that participating in ECPs will bring economic benefit for them, and zero otherwise |
| Non-economic benefits | Dummy variable that takes the value of 1 if the farming household believe that participating in ECPs will bring non-economic benefit for them, and zero otherwise |
| Experience in online sale | Dummy variable that takes the value of 1 if the farming household head has ever sold products online, and zero otherwise |
| Experience in using smartphone | Dummy variable that takes the value of 1 if the farming household head has ever used a smartphone, and zero otherwise |
| Experience in using internet banking | Dummy variable that takes the value of 1 if the farming household head has ever used internet banking, and zero otherwise |
| Support from experts | Dummy variable that takes the value of 1 if the farming household head has ever received assistance from experts to participate in e-commerce, and zero otherwise |
| Government support | Dummy variable that takes the value of 1 if the farming household head has ever received assistance from the government to participate in e-commerce, and zero otherwise |
average difference between the participating and non-participating groups regarding gender and culture. The above results indicate that young, highly educated people tend to participate more in ECPs. The reason might be that young people love technology and explore and experience new things (Lambrecht et al., 2014). Besides, their high level of education makes it easy for them to use the functions in the ECP applications. Even more remarkable is a significant average difference between the participating and non-participating groups.

There is a significant difference in economic benefits, non-economic benefits, experience in online sales, experience in using smart banking, and experts’ support between the participating and non-participating groups. However, there is no significant difference between these two groups in terms of the internet, telecommunications network, experience in using a smartphone, and government support. The results in Table 2 show that the mean economic and non-economic benefits of the households participating in ECPs are higher than those not participating in ECPs. The difference between the participating and non-participating groups in terms of economic and non-economic benefits is statistically significant at the 0.01 level. The average difference in the experience in the online sales between the participating and non-participating groups is 0.297 and statistically significant at the 0.01 level. The percentage of people with online sales experience in the participating group (65.14%) is higher than that of the non-participating group (64.55%). The reason is that those with experience in online sales can easily approach customers thanks to their proficiency in applying various forms of product promotion and customer consultation. The average difference in the experience of using smart banking between the participating and non-participating groups is 0.392 and statistically significant at the 0.01 level.

The last and most important factor is the income of organic tea farmers. According to collected data, organic tea farmers earn an average of 194.74 USD per month through traditional selling channels such as selling to traders, in traditional markets, and to retail customers. Meanwhile, farmers who sell organic tea through e-commerce platforms earn up to 255.48 USD per month. Farming households that participate in ECPs have a higher average income of about 60.74 USD than those that do not. The t-test is statistically significant at the 0.01 level. This result shows a clear difference in the income of households selling organic tea through ECPs and those not selling organic tea through ECPs.

According to Table 3, the percentage of people who have experience using smart banking in the participating group accounts for 75.23%. There are two

### Table 2 Summary of statistics for the participating and non-participating groups

| Variable                  | Participating group (n=109) | Non-participating group (n=189) | Mean differences | Test statistics (t-value) |
|---------------------------|----------------------------|---------------------------------|------------------|---------------------------|
| Age                       | 36.450 7.264               | 40.079 7.582                   | −3.629           | 4.041**                   |
| Gender                    | 0.376 0.487                | 0.481 0.501                    | −0.105           | 1.766                     |
| Culture                   | 0.615 0.489                | 0.561 0.498                    | 0.054            | −0.905                    |
| Education                 | 9.761 3.344                | 8.799 3.510                    | 0.962            | −2.319*                   |
| Income                    | 255.48 0.296               | 194.74 0.201                   | 60.74            | −3.249**                  |
| Internet                  | 0.835 0.373                | 0.767 0.424                    | 0.068            | −1.386                    |
| Telecommunications network| 0.862 0.346                | 0.810 0.394                    | 0.052            | −1.166                    |
| Economic benefits         | 0.651 0.479                | 0.508 0.501                    | −0.143           | −2.418*                   |
| Non-economic benefits     | 0.624 0.487                | 0.603 0.491                    | −0.021           | −0.352                    |
| Experience in online sale | 0.651 0.479                | 0.354 0.480                    | 0.297            | −5.150**                  |
| Experience in using the smartphone | 0.459 0.501 | 0.513 0.501 | −0.054 | 0.905                     |
| Experience in using smart banking | 0.752 0.434 | 0.360 0.481 | 0.392 | −7.027**                  |
| Expert support            | 0.477 0.502                | 0.291 0.455                    | 0.186            | −3.272**                  |
| Government support        | 0.413 0.495                | 0.323 0.469                    | 0.090            | −1.566                    |

Source: Author
payment methods when buying goods on ECPs: payment at home and via smart banking. ECPs often offer free shipping as a percentage of the order value to recover money quickly. Moreover, consumers prefer payment via smart banking over direct methods (Russia, 2021) because it can limit contact and the spread of disease. Since the epidemic outbreak, the number of smart banking users has increased (Reporter group, 2021). This requires that farmers participating in ECPs have experience in using smart banking. In addition, we found that the average difference in expert support between the participating and non-participating groups is 0.186 and statistically significant at the 0.01 level. The percentage of people who receive help from experts in the participating group is about 47.71%, while this rate in the non-participating group accounts for only 29.10%. This result implies the importance of experts in supporting and promoting farmers to sell Vietgap and organic agricultural products on ECPs.

Propensity matching score

Table 4 presents the empirical results of the logit model (Eq. (3)) of the PSM. According to the results in Table 3, the area under the receiver operating characteristic (ROC) curve is 0.848 (>0.7), and the Prob > $\chi^2$ is statistically significant. These imply that the pattern is consistent. The results show that 10 out of 13 explanatory variables significantly impact organic tea households participating in ECPs. Regarding demographic factors, gender and age have a negative impact and have statistical significance at the 0.05 level on farmers’ behavior of participating in ECPs. In contrast, the estimated coefficients of culture and education have a positive but not statistically significant effect. This result confirms that young people and women tend to participate more in ECPs.

The economic and non-economic benefits factors positively and statistically significantly impact farmers’ behavior in selling organic tea through ECPs. These results imply that a clear perception of economic and non-economic benefits from ECPs encourages organic tea farmers to participate more in ECPs. The availability of the internet and telecommunications network has a positive and statistically significant impact on farmers’ behavior in participating in ECPs. People with access to the internet and telecommunications networks have a probability of participating in ECPs at about 17.3% and 17.7%, respectively. Farmers with experience in online sales have a participation

| Variables | Unit | Participating group | Non-participating group |
|-----------|------|---------------------|-------------------------|
|           | Freq | % | Freq | % |
| Internet | Yes 91 | 83.49 | 145 | 76.72 |
|           | No 18 | 16.51 | 44  | 23.28 |
| Telecommunications network | Yes 94 | 86.24 | 153 | 80.95 |
|           | No 15 | 13.76 | 36  | 19.05 |
| Economic benefits | Yes 71 | 65.14 | 96  | 50.79 |
|           | No 38 | 34.86 | 93  | 49.21 |
| Non-economic benefits | Yes 114 | 60.32 | 68  | 62.39 |
|           | No 75 | 39.68 | 41  | 37.61 |
| Experience in online sale | Yes 71 | 65.14 | 67  | 64.55 |
|           | No 38 | 34.86 | 122 | 35.45 |
| Experience in using smartphone | Yes 50 | 45.87 | 97  | 51.32 |
|           | No 59 | 54.13 | 92  | 48.68 |
| Experience in using smart banking | Yes 82 | 75.23 | 68  | 64.02 |
|           | No 27 | 24.77 | 121 | 35.98 |
| Expert support | Yes 52 | 47.71 | 55  | 29.10 |
|           | No 57 | 52.29 | 134 | 70.90 |
| Government support | Yes 45 | 41.28 | 61  | 32.28 |
|           | No 64 | 58.72 | 128 | 67.72 |
probability of 19.5%, implying that online sales experience can help farmers be more confident when selling organic tea through ECPs. The likelihood that a farmer with experience using smart banking will participate in ECPs is 33.1%. Regarding supporting factors, farmers who receive online sales support from the government and experts are 11.4 and 18.1% likely to participate in ECPs, respectively. These results show that knowledge and experience related to ECPs are important factors that motivate farmers to sell on these sites.

Before estimating ATET, we perform a balancing hypothesis, common support assumption and test selection bias after matching. According to Fig. 2, the density distribution of propensity scores for the participating group perfectly overlaps that of the non-participating group. This implies that our data met the common support condition after matching. The results show that knowledge and experience related to ECPs are important factors that motivate farmers to sell on these sites.

To confirm the robustness of the matching technique, we accomplished a test of selection bias after matching, which was suggested by Ehiakpor et al. (2019). According to Table 6, the mean bias was reduced significantly after matching, a reduction in mean bias of about 61.6 to 81.6%. Besides, the pseudo-$R^2$ decreased from 0.307 before matching to 0.011–0.040 after matching. In addition, the joint significance of the likelihood-ratio $\chi^2$ was rejected ($p>0.05$) after matching. These results confirm that the propensity scores matching technique was successful and could be used to assess the impact of participating in ECPs on organic tea farming households’ income.

The impact of participating in ECPs on organic tea farmers’ income

Table 7 presents the effect of participating in ECPs on the income of organic tea households estimated with four matching algorithms, including NN1, NN5, Kernel, and Radius (0.05). According to the data presented, the

| Variables                          | Coef  | Std. err | Marginal effect | Delta-method std. err |
|------------------------------------|-------|----------|-----------------|-----------------------|
| Age                                | −0.059** | 0.021    | −0.009**        | 0.003                 |
| Gender                             | −0.845*  | 0.322    | −0.127**        | 0.047                 |
| Culture                            | 0.058  | 0.317    | 0.009           | 0.048                 |
| Education                          | 0.070  | 0.048    | 0.010           | 0.007                 |
| Internet                           | 1.152** | 0.438    | 0.173**         | 0.064                 |
| Telecommunications network         | 1.175*  | 0.457    | 0.177**         | 0.066                 |
| Economic benefits                  | 0.793*  | 0.318    | 0.119**         | 0.046                 |
| Non-economic benefits              | 0.682*  | 0.325    | 0.103*          | 0.048                 |
| Experience in online sale          | 1.299** | 0.314    | 0.195**         | 0.042                 |
| Experience in using smartphone     | 0.238  | 0.319    | 0.036           | 0.048                 |
| Experience in using smart banking  | 2.202** | 0.349    | 0.331**         | 0.038                 |
| Expert support                     | 1.205** | 0.331    | 0.181**         | 0.046                 |
| Government support                 | 0.757*  | 0.327    | 0.114*          | 0.048                 |
| Constant                           | −4.196**| 1.343    |                 |                       |
| Pseudo $R^2$                       | 0.302  |          |                 |                       |
| Prob $>\chi^2$                     | 0.000  |          |                 |                       |
| Likelihood-ratio $\chi^2$          | 118.22 |          |                 |                       |
| ROC                                | 0.848  |          |                 |                       |
| Number of observations             | 298    |          |                 |                       |

Source. Author
Note. * significant at the 0.05 level; ** significant at the 0.01 level
income of organic tea farming households participating in ECPs is significantly higher than that of households not participating in ECPs. Specifically, organic tea farmers in the participating group have a higher income of 56.13–68.31 USD than those in the non-participating group. The highest earnings are found with the Kernel estimate.

These results emphasize that participating in ECPs in the context of COVID-19 is indeed economically beneficial for organic tea farmers. Customers who love organic products are often high-income people in big cities (e.g., Ha Noi capital, Ho Chi Minh City, Hai Phong City, etc.). These customers are willing to pay higher prices to ensure their and their families’
Table 5  Balancing hypothesis test showing the variable characteristics before and after matching

| Variables                        | Unmatched/matched | Mean | % Bias | % Reduction in bias | p value |
|----------------------------------|-------------------|------|--------|---------------------|---------|
|                                  | Treated           | Control |        |                     |         |
| Age                              | Unmatched         | 36.45 | 40.08  | −48.9               | 0.000   |
|                                  | Matched           | 36.45 | 38.47  | −27.2               | 44.4    | 0.052   |
| Gender                           | Unmatched         | 0.38  | 0.48   | −21.3               | 0.078   |
|                                  | Matched           | 0.38  | 0.32   | 11.1                | 47.7    | 0.396   |
| Culture                          | Unmatched         | 0.61  | 0.56   | 10.9                | 0.366   |
|                                  | Matched           | 0.61  | 0.66   | −9.3                | 14.8    | 0.483   |
| Education                        | Unmatched         | 9.76  | 8.80   | 28.1                | 0.021   |
|                                  | Matched           | 9.76  | 9.46   | 8.8                 | 68.5    | 0.488   |
| Internet                         | Unmatched         | 0.83  | 0.77   | 17.0                | 0.167   |
|                                  | Matched           | 0.83  | 0.91   | −18.4               | −8.5    | 0.106   |
| Telecommunications network       | Unmatched         | 0.86  | 0.81   | 14.3                | 0.245   |
|                                  | Matched           | 0.86  | 0.83   | 7.4                 | 47.9    | 0.573   |
| Economic benefits                | Unmatched         | 0.65  | 0.51   | 29.3                | 0.016   |
|                                  | Matched           | 0.65  | 0.70   | −9.4                | 68.0    | 0.472   |
| Non-economic benefits            | Unmatched         | 0.62  | 0.60   | 4.2                 | 0.725   |
|                                  | Matched           | 0.62  | 0.57   | 11.3                | −166.2  | 0.410   |
| Experience in online sale        | Unmatched         | 0.65  | 0.35   | 62.0                | 0.000   |
|                                  | Matched           | 0.65  | 0.68   | −5.7                | 90.7    | 0.669   |
| Experience in using smartphone   | Unmatched         | 0.46  | 0.51   | −10.9               | 0.366   |
|                                  | Matched           | 0.46  | 0.44   | 3.7                 | 66.3    | 0.787   |
| Experience in using smart banking| Unmatched         | 0.75  | 0.36   | 85.7                | 0.000   |
|                                  | Matched           | 0.75  | 0.71   | 10.0                | 88.3    | 0.448   |
| Expert support                   | Unmatched         | 0.48  | 0.29   | 38.8                | 0.001   |
|                                  | Matched           | 0.48  | 0.54   | −13.4               | 65.5    | 0.345   |
| Government support               | Unmatched         | 0.41  | 0.32   | 18.7                | 0.118   |
|                                  | Matched           | 0.41  | 0.37   | 9.5                 | 49.1    | 0.490   |

Source. Author

Table 6  Test of selection bias after matching

| Matching algorithm | Unmatched/matched | Pseudo-$R^2$ | Likelihood-ratio $\chi^2$ | $p > \chi^2$ Mean bias | % Reduction in mean bias |
|--------------------|-------------------|--------------|---------------------------|------------------------|-------------------------|
| NN1                | Unmatched         | 0.307        | 119.97                    | 0.000                  | 30.0                    | 61.6                   |
|                    | Matched           | 0.040        | 12.07                     | 0.522                  | 11.5                    |                        |
| NN5                | Unmatched         | 0.307        | 119.97                    | 0.000                  | 30.0                    | 81.6                   |
|                    | Matched           | 0.011        | 3.39                      | 0.996                  | 5.5                     |                        |
| Kernel             | Unmatched         | 0.307        | 119.97                    | 0.000                  | 30.0                    | 79.0                   |
|                    | Matched           | 0.018        | 5.23                      | 0.970                  | 6.3                     |                        |
| Radius (0.05)      | Unmatched         | 0.307        | 119.97                    | 0.000                  | 30.0                    | 78.6                   |
|                    | Matched           | 0.015        | 4.46                      | 0.985                  | 6.4                     |                        |

Source. Author
health. Hence, participating in ECPs helps farmers expand their markets and directly reach many potential customers (Ly, 2020).

In the context of the epidemic, local authorities asked people to limit going out and gathering in large numbers to minimize the spread. Although this helps to ensure people’s health, farmers face economic risks because they cannot sell goods at traditional markets, and direct transaction with traders from abroad or neighboring provinces is limited. Thanks to the valuable features of ECPs, farmers can promote and sell organic tea products to people across the country. ECPs allow farmers to display organic tea products according to the geographical location and the customers’ preferences and tastes, which help them to connect with potential customers (Zheng, 2009).

Overall, these empirical results imply that supporting and promoting farmers to put organic tea on ECPs is a valuable solution that helps increase farmers’ income. Therefore, local authorities and farmers’ associations in the northern mountainous provinces should study and support farmers putting agricultural products on ECPs, especially during the current epidemic.

Discussion

Theoretical implication

This research contributes to the existing literature in two dimensions. First, to our knowledge, most of the previous studies have only focused on comparing farmers’ income in cases such as organic conversion (Doanh et al., 2018), farm programs (Pufahl & Weiss, 2008), farmers’ training centers (M. Wordofa & Sassi, 2017), extension program participation (Attipoe et al., 2021), technology adoption (Wordofa et al., 2021a, 2021b; Wu et al., 2010), participation in cooperatives (Dong et al., 2019; Tranet al. 2021; Vuong et al. 2021), output price support (Aboky et al., 2020), and participation in contract farming (Bezabeh et al. 2020; Olounlade et al., 2020). However, there are no studies to evaluate and compare the income of farming households participating and not participating in ECPs, especially in the context of COVID-19. Second, our study is a concrete demonstration of the benefits of participating in ECPs as an organic seller. Our research results are a reference for policy-makers on agricultural economic development and a driving force for clean products-producing farmers to access ECPs.

Managerial implications

Based on the research results and the current epidemic situation in the mountainous provinces of northern Vietnam, selling product through ECPs is probably the most optimal solution for organic farmers. However, a specific strategy and coordination between local authorities, farmers’ associations, banks, and ECPs in Vietnam are required to encourage farmers to use this new selling method.

First, according to empirical results and previous studies, farmers will intend to use ECPs if they perceive benefits, have knowledge and experience in using ECPs or smartphone applications, and get support from experts and the government. (1) To increase awareness of the economic and non-economic benefits of selling organic tea through

Table 7 Estimated treatment effects of participating in ECPs on farmers’ income

| Matching algorithm | Unmatched/matched | Treated | Controls | Difference | Std. err | T-stat |
|-------------------|-------------------|---------|----------|------------|----------|--------|
| NN1               | Unmatched         | 255.48  | 194.74   | 60.74      | 0.321    | 4.35   |
|                   | Matched           | 255.48  | 195.43   | 60.05      | 0.599    | 2.31   |
| NN5               | Unmatched         | 255.48  | 194.74   | 60.74      | 0.321    | 4.35   |
|                   | Matched           | 255.48  | 193.43   | 62.05      | 0.478    | 2.99   |
| Kernel            | Unmatched         | 255.48  | 194.74   | 60.74      | 0.321    | 4.35   |
|                   | Matched           | 255.48  | 187.17   | 68.31      | 0.470    | 3.00   |
| Radius (0.05)     | Unmatched         | 255.48  | 194.74   | 60.74      | 0.321    | 4.35   |
|                   | Matched           | 245.48  | 189.35   | 56.13      | 0.451    | 2.82   |

Source. Author
ECPs, local extension workers and village heads should discuss and analyze the advantages of ECPs for farmers. In addition, local authorities can invite farmers who have achieved good results in selling organic tea through ECPs to hold meetings and share experiences to help other households become more aware of the benefits of ECPs. (2) Although ECPs are already quite common in rural areas, most farmers use ECPs as consumers rather than sellers. Therefore, local authorities should coordinate with representatives of ECPs to develop steps from propaganda and information dissemination to user guidance and accompany farmers in bringing organic agricultural products to ECPs. In addition, it is necessary to coordinate with online sales experts to help farmers promote products and bring product information to consumers effectively.

Second, besides the experience of using applications and smartphones, this study also shows that having experience in using internet banking or smart banking encourages organic tea farmers to sell products through ECPs. Internet banking or smart banking are also new concepts for farmers. They have become more common in rural areas of Vietnam since the disease outbreak. The study of Wang et al. (2003) on factors affecting acceptance of internet banking indicated that ease of use and reliability motivate users to use internet banking. This finding is also emphasized in the study of Malaquias and Silva (2020) with a population of farmers in Brazil. Hanif and Lallie (2021) emphasize the level of safety and security for internet banking services. Therefore, to create the most favorable conditions for farmers to use ECPs and internet banking/smart banking, banks should design applications that ensure the system is easy to use, practical, and reliable. In addition, local authorities should coordinate with banks to organize training sessions on using internet banking/smart banking for farmers.

Finally, for solutions to be highly effective, it is necessary to pay attention to the cultural standards and traditions of the people, especially ethnic minority farmers. Research by Kernecker et al. (2019) on farmers’ perceptions of smart farming technology for cropping systems across Europe suggests that we should put everything in a language that farmers can understand. This implies that bringing new solutions to farmers requires careful consideration, ensuring standard and farmer-friendly factors. Therefore, the proposed solutions and strategies must maintain the mountainous areas’ cultural, social, and customary standards (Dung, 2018).

Conclusion

Using the PSM method and interview data of 298 organic tea farmers in the mountainous provinces of northern Vietnam, this study found that farmers in the participating group had an income of between 56.13 and 68.31 USD higher than those in the non-participating group. This result reflects the positive impact of participating in ECPs on the economic benefits of farming households, especially in the context of the complicated developments of the COVID-19 epidemic. The empirical results demonstrate that ECPs have helped farmers overcome restrictions due to the COVID-19 epidemic by reaching more customers and saving shipping costs. Therefore, we suggest that supporting and promoting farmers to put organic agricultural products on ECPs is a helpful solution that local authorities and farmers’ associations in the mountainous provinces of northern Vietnam should study not only given the current epidemic, but also in the future.

Author contribution NKD suggested ideas, collected data and improved the literature review, and contributed to the discussion section. VHV wrote the introduction, methodology, and conclusion. All authors read and approved the final manuscript.

Data availability Data are available on request from the corresponding author.

Declarations

Conflict of interest The authors declare no competing interests.

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