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Does Participation in Aquaculture Cooperatives Increase Farmers' Profit and Output?

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Abstract: Individual aquaculture farmers in developing countries play an important role in ensuring food security. This study uses survey data from aquaculture households in Rongcheng and Xiangshan cities in China to explore the impact of cooperative participation on the benefits to the aquaculture households. The empirical results show that the participation of aquaculture farmers in cooperatives has effectively increased their net profit and output per unit area. On average, participating in cooperatives increased the net profit and output per unit area of farmers by approximately 15.55% and 11.47%, respectively. The test results of the mechanism show that the information services, technical training, and product sales guidance provided by the cooperatives have increased the net profit of the farmers. At the same time, the information services and product sales guidance provided by cooperatives are important reasons for the increase in the output per unit area.

Keywords: aquaculture cooperatives; net profit; output per unit area; aquaculture farmers

1. Introduction

Aquaculture plays a vital role in ensuring food security worldwide. Internationally, China accounts for more than 30% of the world’s total aquatic product output, making it the world’s largest aquatic product producer. However, aquaculture in China is dominated by self-employed individual farmers. It has been argued that individual farmers are often in a disadvantageous position in the market and lack the ability to bargain in comparison with agribusiness [1,2]. In addition, farmers often face many risks in agricultural production, such as disease risks, production risks, market risks, and climate risks [3,4]. It is often difficult for individual farmers to cope with such risks. In fact, there are already some measures to reduce farmers’ risk; the key issue is how to promote the adoption of these measures by farmers [5,6]. Agricultural credit [7–9], agricultural extension [10,11], cooperatives [12], and other factors are considered to influence farmers’ adoption of risk prevention and control measures. Among these, cooperatives play an important role in alleviating farmers’ risks and increasing their incomes.

Agricultural cooperatives are an important force in the agricultural sector, helping farmers alleviate poverty through high production and profitability [13–16]. Cooperatives make it possible for farmers to enhance the collective action by which they can acquire a greater voice in the factor and product markets, which cannot be acquired individually [15]. Collective action can also generate economies of scale that reduce information asymmetry and transaction costs [17]. A large number of studies have empirically verified the impact of participation in cooperatives on agricultural productivity or income [18–21]. The conclusions of these studies tend to show that cooperative participation can significantly improve the productivity or income of farmers. However, the size of this positive promoting effect may be related to the scale of farmers’ production. In general, small-scale farmers gain more from participating in cooperatives than large-scale farmers [18]. In addition, some studies...
have examined the heterogeneity of the economic impact of cooperative participation from the perspectives of engagement in off-farm work or lack of it, household income, market proximity, education level, age, and so on [21,22].

There have been various studies on the effect of agricultural cooperatives on farm productivity, price and household welfare [22–25], farm inputs [26], and farmers’ adoption of new technologies [27] in developing countries. However, existing research focuses on crop farmers rather than aquaculture farmers. Moreover, prior studies on the effect of cooperatives on aquaculture are mostly qualitative analyses [28], which could not objectively measure the impact of cooperative participation on aquaculture farmers. Therefore, the primary objective of this study is to explore the impact of cooperative membership on farmers’ income and production. The empirical analysis of this study is based on the fish farm survey data collected from two regions in China. This paper contributes to the existing literature in two aspects. First, to the best of the authors’ knowledge, this is the first study to explore the quantitative impact of cooperative membership on aquaculture farmers’ income and production using data from China. Prior studies mostly focus on the cooperative membership effect on crop farmers or farm households. Second, this research explores the mechanism of the influence of cooperative participation on the income and output of aquaculture farmers from three dimensions: information supply, technical training, and product sales guidance.

2. Methods and Data

2.1. Model Settings

The purpose of this study is to explore the effect of cooperative participation on aquaculture farmers’ benefits. We divided these benefits into two categories: one was economic gains, and the other was yield gains. The models used to test the two types of effects are as follows:

\[
\ln \text{profit}_i = \beta_0 + \beta_1 \text{fishcoo}_i + \sum_{j=2}^{9} \beta_j \text{Control}_{ij} + \epsilon_i
\]

\[
\ln \text{output}_i = \alpha_0 + \alpha_1 \text{fishcoo}_i + \sum_{j=2}^{9} \alpha_j \text{Control}_{ij} + \epsilon_i
\]

where both \(\ln \text{profit}_i\) and \(\ln \text{output}_i\) are dependent variables, which represent the net profit and output per unit area obtained by Farmer \(i\) from engaging in aquaculture, respectively. \(\text{fishcoo}_i\) is an independent variable, which represents whether Farmer \(i\) participates in a cooperative. When a farmer participates in a cooperative, it takes the value of 1. Otherwise, its value is taken as 0. When \(\beta_1\) is greater than 0 and statistically significant, it indicates that participating in the cooperative increases the net profit of the farmer engaged in aquaculture. Similarly, when \(\alpha_1\) is greater than 0 and statistically significant, it means that participation in a cooperative increases the output per unit area engaged in aquaculture. \(\sum_{j=2}^{9} \beta_j \text{Control}_{ij}\) represents the control variable, including sex, nationality, educational background, number of relatives and friends, village cadre status, farming area, farming experience, family size, and age. \(\epsilon_i\) is an i.i.d disturbance term.

2.2. Data Sources

The data in this study mainly came from questionnaires. The survey was conducted from January to June 2021. The survey samples were collected from aquaculture households in Rongcheng City, Shandong Province, and Xiangshan County, Zhejiang Province. In 2019, aquaculture output in Zhejiang and Shandong accounted for about 16.72 percent of the total national output, and aquaculture output accounted for about 15.86 percent of the total output. Although the output and output value of aquaculture in the two provinces is not high in China, the number of individual aquaculture farmers in the two provinces is at the
forefront of the country. Stratified random sampling was adopted to ensure good sample coverage. The specific process was as follows: we randomly selected 5 towns (subdistrict offices) in each area, 6 villages in each town (subdistrict office), and finally 10 aquaculture households in each village. A total of 600 questionnaires were distributed in the whole data research process. Some incomplete or inconsistent data were excluded. In all, 586 valid questionnaires were returned, giving rise to a questionnaire response rate of 97.7%. The survey mainly covered farmers' basic personal characteristics, family management, fishery cooperative organizations, breeding area, fishery factor inputs, etc.

2.3. Variables Description

The dependent variables in this study were the net profit and output per unit area of farmers engaged in aquaculture, while the independent variable was the status of the aquaculture farmer’s participation in a cooperative. The value of this independent variable was taken as 1 for participation in a cooperative and 0 for no participation in a cooperative. In this study, 39.1% of the surveyed households participated in cooperatives. As for the mechanism study, three mechanism variables, namely information service, technical training, and product sales guidance, were also considered. All three mechanism variables were graded. For example, on a 1–5 scale, information service measures how frequently the farmers participating in the cooperatives obtained information from the cooperatives. In addition, this study also added a series of control variables including sex, educational background, experience, etc., to minimize the bias of omitted variables. Table 1 shows the descriptive statistics for each variable.

Table 1. Descriptive statistics of all variables.

| Variable | Description | Observation | Mean | Std.Dev | Min | Max |
|----------|-------------|-------------|------|---------|-----|-----|
| lnprofit | Logarithm of net profit (CNY) | 586 | 11.341 | 0.420 | 9.656 | 12.222 |
| lnoutput | Logarithm of output per unit area (kg) | 586 | 6.322 | 0.098 | 6.168 | 6.533 |
| fishco   | Whether farmer $i$ has participated in a cooperative | 586 | 0.391 | 0.488 | 0.000 | 1.000 |
| inform   | Frequency of information services provided by cooperatives | 586 | 2.382 | 1.591 | 1.000 | 5.000 |
| techno   | Frequency of technical training provided by cooperatives | 586 | 3.096 | 1.706 | 1.000 | 5.000 |
| pro      | Frequency of product sales guidance provided by cooperatives | 586 | 3.171 | 1.755 | 1.000 | 5.000 |
| Sex      | 1 = male, 0 = female | 586 | 0.176 | 0.381 | 0.000 | 1.000 |
| Ethnicity| 1 = Han nationality, 0 = Other ethnic groups | 586 | 0.874 | 0.332 | 0.000 | 1.000 |
| Education| Years of education for farmers | 586 | 2.826 | 1.480 | 1.000 | 8.000 |
| Friends  | Number of friends and relatives | 586 | 7.360 | 3.428 | 2.000 | 13.000 |
| Villcad  | 1 = village cadres, 0 = not village cadres | 586 | 0.138 | 0.345 | 0.000 | 1.000 |
| lnCularea| Logarithm of aquaculture area (0.01 hectares) | 586 | 2.844 | 0.303 | 2.197 | 3.332 |
| Exp      | Number of years engaged in aquaculture | 586 | 9.454 | 5.018 | 1.000 | 18.000 |
| Famsize  | Total household size | 586 | 5.534 | 1.703 | 3.000 | 8.000 |
| Age      | Age of farmer | 586 | 40.036 | 8.674 | 21.000 | 66.000 |

3. Results

3.1. Baseline Estimations

Table 2 shows the estimation results of the effect of cooperative participation on farmers’ economic benefits. Columns (2) and (4) of Table 2 correspond to the regression results of Models (1) and (2), respectively. For comparison, the regression results of the control variables not considered are shown in Columns (1) and (3).
Table 2. Estimation results of cooperative participation benefits.

|       | (1)    | (2)    | (3)    | (4)    |
|-------|--------|--------|--------|--------|
|       | lnoutput | lnoutput | lnprofit | lnprofit |
| fishcoo | 0.1339 *** | 0.1555 *** | 0.3328 *** | 0.1147 *** |
|        | (0.0039) | (0.0030) | (0.0328) | (0.0191) |
| Sex    | −0.0038 | 0.0313  | (0.0035) | (0.0224) |
| Ethnicity | 0.0001  | −0.0393 | (0.0040) | (0.0261) |
| Education | 0.0008  | 0.0425 *** | (0.0010) | (0.0066) |
| Friends | 0.0001  | −0.0003 | (0.0004) | (0.0025) |
| Villcad | −0.0055 | 0.0494 ** | (0.0038) | (0.0247) |
| lnCularea | −0.1294 *** | 1.0585 *** | (0.0073) | (0.0475) |
| Exp    | 0.0010 ** | −0.0025 | (0.0004) | (0.0026) |
| Fansize | 0.0006  | 0.0053  | (0.0008) | (0.0050) |
| Age    | −0.0000 | −0.0003 | (0.0002) | (0.0010) |
| Constant | 6.3910 *** | 6.7367 *** | 11.2114 *** | 8.1964 *** |
|        | (0.0024) | (0.0196) | (0.0205) | (0.1266) |

N  586  586  586  586

Adj R²  0.67  0.84  0.15  0.76

Note: The standard errors in parentheses; *** and ** after numbers indicate that the significance level of 1% and 5% passed the significance test.

Column (1) of Table 2 shows that without adding the control variables, the estimated correlation coefficient of fishcoo was 0.1339, which was statistically significant at the 1% level. It indicates that compared with farmers who did not participate in the cooperatives, farmers participating in the farming of the cooperatives had a higher output per unit area. Column (2), with the addition of the control variables, shows that the estimated correlation coefficient of fishcoo increased to 0.1555, still statistically significant at the 1% significance level. It means that relative to farmers who did not participate in the cooperatives, the average output per unit area of farmers participating in the cooperative increased by about 15.55%. This is an estimated result with significant economic significance. According to Column (3), when the control variables were not added, the estimated correlation coefficient of fishcoo was 0.3328 and statistically significant; that is, farmers who participated in the cooperatives had higher net profits. After the control variables were considered, the estimated coefficient dropped to 0.1147, which means that participation in cooperatives increased the net profit of aquaculture households by about 11.47%, which is of significant economic significance.

3.2. Heterogeneity Test

The impact of cooperative participation on the net profit and output per unit area of aquaculture farmers may vary among farmers with different characteristics. The survey data in this study came from Rongcheng and Xiangshan in China. These two cities have significant differences in geographical location and economic development. Because of these differences, the effect of cooperative participation on the net profit and output per unit area of aquaculture farmers may also be different. For example, Xiangshan belongs to the East China Sea, while Rongcheng belongs to the Yellow Sea. Water pollution in the East China Sea is more severe than that in the Yellow Sea, which may reduce aquaculture production and product quality in the East China Sea, thus affecting economic returns.
Therefore, this study constructed a regional dummy variable \( region \). When the investigated farmer belonged to Xiangshan, this variable was set to 1, otherwise, it was set to 0. The estimated results of \( fishcoo \) and \( region \) cross-product coefficients are respectively shown in Columns (1) and (2) of Table 3. The results show that the coefficient of \( fishcoo \times region \) was positive in Column (1) and statistically insignificant. Therefore, the effect of cooperative participation on net profit was not significantly different between Rongcheng and Xiangshan. In Column (2), the estimated coefficient of the \( fishcoo \times region \) was significantly negative, which means that participation in cooperatives had a greater promotional effect on the output per unit area in Rongcheng than in Xiangshan.

### Table 3. Heterogeneity test results based on region and village cadre status.

|       | (1)       | (2)      | (3)       | (4)       |
|-------|-----------|----------|-----------|-----------|
|       | \( \ln{profit} \) | \( \ln{output} \) | \( \ln{profit} \) | \( \ln{output} \) |
| \( fishcoo \) | 0.0989 *** | 0.1600 *** | 0.1204 *** | 0.1550 *** |
|       | (0.0254)  | (0.0039)  | (0.0205)  | (0.0032)  |
| \( fishcoo \times region \) | 0.0297   | -0.0095 * |           |           |
|       | (0.0349)  | (0.0054)  |           |           |
| \( fishcoo \times Villcad \) |           | -0.0387  | 0.0037    |           |
|       |           | (0.0496)  | (0.0077)  |           |
| Sex   | 0.0294    | -0.0038  | 0.0305    | -0.0037   |
|       | (0.0224)  | (0.0035)  | (0.0224)  | (0.0035)  |
| Ethnicity | -0.0408   | -0.0002  | -0.0391   | 0.0001    |
|       | (0.0261)  | (0.0040)  | (0.0261)  | (0.0040)  |
| Education | 0.0429 *** | 0.0007   | 0.0423 *** | 0.0008    |
|       | (0.0066)  | (0.0010)  | (0.0066)  | (0.0010)  |
| Friends | -0.0000   | 0.0001   | -0.0004   | 0.0001    |
|       | (0.0025)  | (0.0004)  | (0.0025)  | (0.0004)  |
| Villcad | 0.0484 *  | -0.0054  | 0.0675 ** | -0.0072   |
|       | (0.0246)  | (0.0038)  | (0.0339)  | (0.0052)  |
| \( \ln{Cularea} \) | 1.0618 *** | -0.1295 *** | 1.0590 *** | -0.1295 *** |
|       | (0.0475) | (0.0073)  | (0.0475)  | (0.0074)  |
| Exp   | -0.0026   | 0.0010 ** | -0.0026   | 0.0010 ** |
|       | (0.0026)  | (0.0004)  | (0.0026)  | (0.0004)  |
| Famsize | 0.0061    | 0.0006   | 0.0053    | 0.0006    |
|       | (0.0051)  | (0.0008)  | (0.0050)  | (0.0008)  |
| Age   | -0.0002   | -0.0000  | -0.0003   | -0.0000   |
|       | (0.0010)  | (0.0002)  | (0.0010)  | (0.0002)  |
| Constant | 8.1696 *** | 6.7356 *** | 8.1963 *** | 6.7367 *** |
|       | (0.1275) | (0.0197)  | (0.1266)  | (0.0196)  |
| \( N \) | 586       | 586      | 586       | 586       |
| \( \text{Adj } R^2 \) | 0.76      | 0.84     | 0.76      | 0.84      |

Note: The standard errors in parentheses; ***, **, and * after numbers indicate that the significance level of 1%, 5%, and 10% passed the significance test.

According to Table 1, about 13.8% of the aquaculture farmers were village cadres. Such cadre status may enable farmers to obtain more information in the cooperatives and thus additional benefits. Therefore, this study constructed a cross-product term for cooperative participation and village cadre status and used the estimated coefficient of the cross-product term to reflect the difference between village cadre status and non-village cadre status. The estimation results are shown in Columns (3) and (4) of Table 3. The results show that the estimated coefficients of the cross-product term \( fishcoo \times Villcad \) were not significant. Therefore, it can be concluded that the aquaculture farmers who are village cadres have not obtained higher net profit and output per unit area than the non-cadre aquaculture farmers.

In addition, this study also explored whether there were significant differences in the effect of cooperative participation on the net profit and output per unit area among farmers of different ages, education levels, and sexes, respectively. Table 4 shows the result...
of whether the economic benefits brought by cooperative participation changed with the changes in farmers’ age, education level, and sex. According to Table 4, the coefficient of the cross term between cooperative participation and age was positive and negative in Columns (1) and (2) respectively, but it was statistically significant only in the case of Column (2). It shows that there was no significant difference in the effect of cooperative participation on the net profit among farmers of different ages. Meanwhile, the older the farmers, the weaker the promotional effect of cooperative participation on output per unit area. The coefficient of the cross term between cooperative participation and education was significantly negative and positive in Columns (3) and (4), respectively. For those farmers with a higher educational level, cooperative participation had a weaker effect on net profit but a stronger effect on output per unit area. The estimated coefficients of cooperative participation and sex were both positive and statistically insignificant, indicating that there was no significant difference in the promotional effect of cooperative participation on net profit and output per unit area between male and female farmers.

Table 4. Heterogeneity test results based on age, education, and gender.

|             | (1) lnprofit | (2) lnoutput | (3) lnprofit | (4) lnoutput | (5) lnprofit | (6) lnoutput |
|-------------|--------------|--------------|--------------|--------------|--------------|--------------|
| fishcoo     | 0.1107 *     | 0.1761 ***   | 0.2853 ***   | 0.1201 ***   | 0.1121 ***   | 0.1553 ***   |
|             | (0.0617)     | (0.0095)     | (0.0400)     | (0.0061)     | (0.0209)     | (0.0032)     |
| fishcoo*Age | 0.0011       | −0.0094 **   | −0.0571 ***  | 0.0119 ***   |              |              |
|             | (0.0268)     | (0.0041)     | (0.0118)     | (0.0018)     |              |              |
| fishcoo*Edu |              |              |              |              |              |              |
|             |              |              |              |              |              |              |
| Sex         | 0.0295       | −0.0044      | 0.0245       | −0.0023      | 0.0261       | −0.0043      |
|             | (0.0224)     | (0.0035)     | (0.0220)     | (0.0033)     | (0.0283)     | (0.0044)     |
| Ethnicity   | −0.0418      | 0.0001       | −0.0385      | −0.0000      | −0.0392      | 0.0002       |
|             | (0.0261)     | (0.0040)     | (0.0256)     | (0.0039)     | (0.0261)     | (0.0040)     |
| Education   | 0.0426 ***   | 0.0009       | 0.0735 ***   | −0.0056 ***  | 0.0427 ***   | 0.0008       |
|             | (0.0066)     | (0.0010)     | (0.0091)     | (0.0014)     | (0.0066)     | (0.0010)     |
| Friends     | −0.0000      | 0.0001       | −0.0004      | 0.0001       | −0.0003      | 0.0001       |
|             | (0.0025)     | (0.0004)     | (0.0025)     | (0.0004)     | (0.0025)     | (0.0004)     |
| Villcad     | 0.0486 **    | −0.0058      | 0.0445 *     | −0.0044      | 0.0497 **    | −0.0054      |
|             | (0.0247)     | (0.00038)    | (0.0242)     | (0.0037)     | (0.0247)     | (0.0038)     |
| InCularea   | 1.0614 ***   | −0.1295 ***  | 1.0230 ***   | −0.1221 ***  | 1.0584 ***   | −0.1294 ***  |
|             | (0.0475)     | (0.0073)     | (0.0472)     | (0.0072)     | (0.0475)     | (0.0074)     |
| Exp         | −0.0026      | 0.0010 **    | −0.0016      | 0.0008 **    | −0.0025      | 0.0010 **    |
|             | (0.0026)     | (0.0004)     | (0.0025)     | (0.0004)     | (0.0026)     | (0.0004)     |
| Famsize     | 0.0061       | 0.0006       | 0.0064       | 0.0004       | 0.0054       | 0.0006       |
|             | (0.0051)     | (0.0008)     | (0.0050)     | (0.0008)     | (0.0051)     | (0.0008)     |
| Age         | −0.0002      | 0.0002       | −0.0003      | 0.0000       | −0.0003      | −0.0000      |
|             | (0.0012)     | (0.0002)     | (0.0010)     | (0.0001)     | (0.0010)     | (0.0002)     |
| Constant    | 8.1687 ***   | 6.7266 ***   | 8.2050 ***   | 6.7349 ***   | 8.1964 ***   | 6.7367 ***   |
|             | (1.305)      | (0.0202)     | (1.242)      | (0.0189)     | (1.267)      | (0.0196)     |
| N           | 586          | 586          | 586          | 586          | 586          | 586          |
| r2_a        | 0.76         | 0.84         | 0.77         | 0.85         | 0.76         | 0.84         |

Note: The standard errors in parentheses; ***, *, and + after numbers indicate that the significance level of 1%, 5% and 10% passed the significance test.

3.3. Mechanism Analysis

In the above empirical results, we verified that cooperative participation can significantly increase the net profit and output per unit area of farmers engaged in aquaculture. The further question that needs to be answered is how cooperative participation brings these benefits to farmers. That is, what is the mechanism by which cooperative participation affects the farmers’ benefits? To answer this question, we designed three questions...
in the questionnaire, involving the frequency of information services that aquaculture farmers obtained from cooperatives, the frequency of technical training, and the frequency of product sales guidance. By examining the effect of these three variables on net profit and output per unit area, the underlying mechanism could be revealed. Table 5 shows the test results of the mechanism of the effect of cooperative participation on the economic benefits of aquaculture farmers. Columns (1) and (2) of Table 5 give the estimated results of the effect of information services on net profit and output per unit area, and Columns (3) and (4) give the estimated results of the effect of technical training on the net profit and output per unit area. Column (5) gives the estimated results of the effect of product sales guidance on net profit.

Table 5. Test results of the sources of benefits from cooperative participation.

|                  | (1) | (2) | (3) | (4) | (5) | (6) |
|------------------|-----|-----|-----|-----|-----|-----|
| lnprofit         | 0.0133 ** (0.0064) | 0.0292 *** (0.0020) | 0.0535 *** (0.0062) | −0.0105 (0.0065) | 0.0518 *** (0.0059) | 0.0660 *** (0.0008) |
| lnoutput         | 0.0220 (0.0017) | −0.0165 (0.0017) | 0.0222 (0.0017) | −0.0016 (0.0016) | 0.0222 (0.0017) | −0.0016 (0.0016) |
| President        | 0.0202 (0.0016) | 0.0251 (0.0016) | 0.0251 (0.0016) | 0.0031 (0.0016) | 0.0031 (0.0016) | 0.0031 (0.0016) |
| Sex              | 0.0230 (0.0017) | −0.0028 (0.0017) | 0.0122 (0.0017) | −0.0016 (0.0016) | 0.0122 (0.0017) | −0.0016 (0.0016) |
| Ethnicity        | 0.0068 (0.0017) | 0.0021 (0.0017) | 0.0066 (0.0017) | 0.0070 (0.0017) | 0.0065 (0.0017) | 0.0075 (0.0017) |
| Education        | 0.0026 (0.0017) | 0.0082 (0.0017) | 0.0251 (0.0017) | 0.0266 (0.0017) | 0.0251 (0.0017) | 0.0275 (0.0017) |
| Friends          | 0.0026 (0.0017) | 0.0082 (0.0017) | 0.0251 (0.0017) | 0.0266 (0.0017) | 0.0251 (0.0017) | 0.0275 (0.0017) |
| Villcad          | 0.0541 ** (0.0068) | −0.0016 (0.0016) | 0.0430 (0.0016) | 0.0280 (0.0016) | 0.0370 (0.0016) | −0.0091 (0.0016) |
| InCularea        | 0.0253 (0.0017) | 0.0078 (0.0017) | 0.0239 (0.0017) | 0.0253 (0.0017) | 0.0240 (0.0017) | 0.0071 (0.0017) |
| lnCularea        | 1.1143 *** (0.0492) | −0.0834 *** (0.0466) | 1.0071 *** (0.0493) | 0.2698 *** (0.0497) | 0.9940 *** (0.0470) | −0.1086 *** (0.0136) |
| lnCularea        | 0.0026 (0.0016) | 0.0098 (0.0016) | 0.0024 (0.0016) | 0.0026 (0.0016) | 0.0024 (0.0016) | 0.0007 (0.0016) |
| lnCularea        | 0.0057 (0.0016) | 0.0012 (0.0016) | 0.0053 (0.0016) | 0.0012 (0.0016) | 0.0045 (0.0016) | −0.0003 (0.0016) |
| lnCularea        | 0.0000 (0.0003) | 0.0004 (0.0003) | 0.0000 (0.0003) | 0.0001 (0.0003) | −0.0001 (0.0003) | 0.0001 (0.0003) |
| lnCularea        | 8.0723 *** (0.1299) | 6.6247 *** (0.0401) | 8.2897 *** (0.1232) | 5.9011 *** (0.1302) | 8.3254 *** (0.1241) | 6.8874 *** (0.0368) |

Note: The standard errors in parentheses; ***, ** and * after numbers indicate that the significance level of 1%, 5% and 10% passed the significance test.

According to Columns (1) and (2) of Table 5, the estimated coefficients of the extent to which cooperatives provided information services were 0.0133 and 0.0292, respectively, and they were statistically significant. This means that the higher the frequency of information services provided by cooperatives, the greater the net profit and output per unit area of aquaculture. The estimated coefficients of the frequency of technical training provided by cooperatives were 0.0535 and −0.0105 respectively, but they were only statistically significant in the case of Column (3). This indicates that the higher the frequency of technical training that the farmers obtain from the cooperative, the higher the net profit. This may be because the technical training that farmers receive is mainly to improve the quality of aquatic products, and the improvement in quality has prompted them to sell at higher prices in the market, thereby obtaining more profits. According to Columns (5) and (6) of Table 5, the estimated coefficients of the information service variable were both positive
and statistically significant. This indicates that the higher the frequency of product sales guidance provided by cooperatives, the higher the net profit and output per unit area. Cooperative participation improves net profits by enabling farmers to obtain more information, technical training, and product sales guidance services. At the same time, cooperative participation increases output per unit area by giving farmers access to more information and product sales guidance services.

4. Discussion

4.1. The Effect of Cooperative Participation on Farmers’ Profit and Output

The results of the baseline regression showed that farmers’ participation in cooperatives could significantly improve their net profits and output per unit area. Numerous studies on agriculture have reached similar conclusions [22,29–31]. The reasons behind this are well documented. First, cooperatives can promote collective action and reduce transaction costs [32,33]. For example, cooperatives can provide farmers with unified agricultural supplies, unified management, unified sales, and other services, giving full play to the advantages of economies of scale and reducing costs. Second, participation in cooperatives enhance farmers' bargaining power in the market [34]. Third, cooperatives provide production and sales information [29]. The information comes either from word of mouth among cooperative members or from collective action. Fourth, participation in cooperatives expands political influence, enabling farmers to gain more policy support [35]. For example, in China, the Law on Specialized Farmer Cooperatives stipulates that the central and local finance departments shall allocate funds, respectively, to provide support for specialized farmer cooperatives to carry out services such as information, training, agricultural infrastructure construction, and technology extension. At the same time, professional cooperatives also receive tax benefits.

In the mechanism analysis part, this study empirically explored the mechanism behind cooperative participation on the improvement of net profit and unit area yield from three aspects: information, technical training, and product sales guidance. The results showed that the information, technical training, and product sales guidance provided by cooperatives significantly increased the net profit of farmers. Meanwhile, only the information and product sales guidance significantly improved the output per unit area, while the technical training did not significantly affect the output per unit area. The increase in the frequency of technical training services provided by cooperatives significantly improved net profits but had no significant impact on output per unit area. The reason behind this may be that the technical training provided by cooperatives focuses on improving the quality of aquatic products rather than on increasing yields. The Chinese government is vigorously promoting training on green breeding technology, which can improve the quality of aquatic products, although it cannot increase the output in the short term.

4.2. The Heterogeneity in Effect of Cooperative Participation on Farmers’ Profit and Output

Several important conclusions were drawn from the heterogeneity test. First, cooperative participation promoted the output per unit area of Rongcheng farmers more than that of Xiangshan farmers. Rongcheng, a county-level city in Shandong Province, China, has been known as the top city in aquatic product output for 39 consecutive years and won the title of “National Demonstration Zone of Healthy Aquaculture and Ecological Aquaculture” in 2021. Rongcheng outperforms Xiangshan in aquaculture and the development of aquaculture cooperatives. Second, there was no significant difference in the effect of cooperative participation on net profit and output per unit area between the sampled farmers who were village cadres and those who were not. The reason for this result may be that village leadership may bring a double effect. On the one hand, village cadre status requires them to undertake routine work in the daily operation of cooperatives, which will take up the time they invest in aquacultural activities. Thus, cooperative participation will reduce the benefits of farmers who are village cadres. On the other hand, compared with
non-cadre village farmers, farmers who are village cadres can obtain more information and benefits when participating in cooperatives.

Third, the older the farmer, the smaller the profits and output benefits brought by cooperative participation. Some literature has verified that the increasing age of farmers affects the probability of their participation in cooperatives to a certain extent [30,36]. Older farmers are less able to learn than younger farmers, which prevents them from taking full advantage of the benefits offered by cooperatives. Fourth, with the improvement in farmers’ educational level, the promotional effect of cooperative participation on net profit was weakened, but the promotional effect on output per unit area was strengthened. In fact, most of China’s aquaculture cooperatives focus on the production end and offer little help to farmers at the sales end. The production end mostly depends on technical factors, which is more favorable for farmers with a higher educational level. At the sales end, some farmers have a low educational level, but they may have more breeding experience and are relatively familiar with the market. At the same time, they can obtain more market information through cooperatives to promote aquatic product sales and increase net profits. Finally, there was no significant difference between male and female farmers in the promotional effect of cooperative participation on net profit and output per unit area. This may be mainly because most aquaculture activities in China are family-based, and even if the farmers are female, their husbands are still involved. Therefore, sex did not affect the profits and output benefits brought by cooperative participation.

4.3. The Limitations and Research Prospect

There are still some issues to be solved in this study. On the one hand, when individual farmers become organized, their premium ability in the market can be enhanced, thus increasing their net profits. Due to data availability, this study was unable to explore this mechanism. At the next step, market factors will be considered in the questionnaire to improve the mechanism analysis of the effect of cooperative participation on farmers’ income. On the other hand, the heterogeneity of cooperatives was not adequately considered. For example, breeding cooperatives can be either government-driven or spontaneously organized by farmers. These two types of cooperatives have significant differences in external support, which may cause heterogeneity in the impact on members’ benefits. In future studies, the heterogeneity of cooperatives will be further considered, so as to more comprehensively examine the impact of cooperative participation on farmers’ benefits. In addition, there may be a time gap between cooperative participation and economic effects. This time gap was not considered in this study. While the existence of this time gap does not alter the results of significant economic gains from cooperative participation, it may underestimate the economic gains. In future research, we will add an option for the duration of cooperative participation in the questionnaire design to more accurately estimate the economic impact of cooperative participation.

5. Conclusions and Policy Implications

This study used survey data from aquaculture households in Rongcheng and Xiangshan, cities in China, to explore the effect of cooperative participation on aquaculture farmers’ net profit and output per unit area. Our study showed that the participation of aquaculture farmers in cooperatives significantly increased their net profit and output per unit area. On average, participating in cooperatives increased the net profit and output per unit area of farmers by approximately 15.55% and 11.47%, respectively. Cooperative participation promoted the output per unit area of Rongcheng farmers more than that of Xiangshan farmers. The older the farmers, the smaller the profits and output benefits brought by cooperative participation. With the improvement in farmers’ educational level, the promotional effect of cooperative participation on net profit was weakened, but the promotional effect on output per unit area was strengthened. Cooperative participation improved net profits by enabling farmers to obtain more information, technical training, and product sales guidance services. At the same time, cooperative participation increased
output per unit area by giving farmers access to more information and product sales
guidance services.

The policy implications of our results are as follows. Firstly, in the current context
of rural revitalization, the Chinese government should take various policy measures to
encourage farmers to participate in professional farming cooperatives, so as to help farmers
increase their income. This is especially important for China’s large aquaculture provinces
such as Zhejiang and Shandong. Secondly, cooperatives should increase support for older
farmers, and at the same time, establish a mutual aid mechanism between experienced
older farmers and well-educated young farmers, so as to give full play to their respective
advantages and maximize the economic benefits. Thirdly, the government should establish
a normalized assistance mechanism for cooperatives and provide support in aquaculture
information, technical training, and market information, such as regularly sharing the latest
aquaculture technology and market information with cooperatives and conducting regular
technical training.

Author Contributions: Conceptualization: D.C. and Q.H. methodology: P.T. and X.W. draft writing:
D.C., review and editing: P.T., X.W. and Q.H. All authors have read and agreed to the published
version of the manuscript.

Funding: This work was supported by grant 71874092 from the National Natural Science Foundation of
China in 2018; grant 2021C38037 from Planning of Soft Science Research of Zhejiang Province in 2021.

Data Availability Statement: The data in this study mainly came from questionnaires. The survey
samples were collected from aquaculture households in Rongcheng City, Shandong Province, and
Xiangshan County, Zhejiang Province.

Acknowledgments: We appreciate all the subjects for giving their consent to participate in this
project. The authors gratefully thank the editor and anonymous reviewer for their review.

Conflicts of Interest: The authors declare no conflict of interest.

References
1. Singh, S. Contracting Out Solutions: Political Economy of Contract Farming in the Indian Punjab. World Dev. 2002, 30, 1621–1638. [CrossRef]
2. Masakure, O.; Henson, S. Why do small-scale producers choose to produce under contract? Lessons from nontraditional vegetable
exports from Zimbabwe. World Dev. 2005, 33, 1721–1733. [CrossRef]
3. Kam, S.P.; Badjeck, M.C.; Teh, L.; Teh, L.; Tran, N. Autonomous Adaptation to Climate Change by Shrimp and Catfish Farmers in
Vietnam’s Mekong River Delta. 2012. Available online: https://aquadocs.org/bitstream/handle/1834/26881/WF_3395.pdf?
sequence=1&isAllowed=y (accessed on 7 June 2019).
4. Joffre, O.M.; Poortvliet, P.M.; Klerks, L. To cluster or not to cluster farmers? Influences on network interactions, risk perceptions,
and adoption of aquaculture practices. Agric. Syst. 2019, 173, 151–160. [CrossRef]
5. Garforth, C.J.; Bailey, A.P.; Tranter, R.B. Farmers’ attitudes to disease risk management in England: A comparative analysis of
sheep and pig farmers. Prev. Vet. Med. 2013, 110, 456–466. [CrossRef]
6. Patt, A.; Suarez, P.; Hess, U. How do small-holder farmers understand insurance, and how much do they want it? Evidence from
sheep and pig farmers. Prev. Vet. Med. 2010, 20, 153–161. [CrossRef]
7. Saqib, S.E.; Ahmad, M.M.; Panezai, S.; Ali, U. Factors influencing farmers’ adoption of agricultural credit as a risk management
strategy: The case of Pakistan. Int. J. Disaster Risk Reduct. 2016, 17, 67–76. [CrossRef]
8. Orok, A.; Ayim, S. The impact of agricultural credit guarantee scheme fund on agricultural sector development in Nigeria. Int.
Rev. Manag. Bus. Res. 2017, 6, 1104–1116.
9. Narayanan, S. The productivity of agricultural credit in India. Agric. Econ. 2016, 47, 399–409. [CrossRef]
10. Sapbamrer, R.; Thammachai, A. A Systematic Review of Factors Influencing Farmers’ Adoption of Organic Farming. Sustainability
2021, 13, 3842. [CrossRef]
11. Wuepper, D.; Roleff, N.; Finger, R. Does it matter who advises farmers? Pest management choices with public and private
extension. Food Policy 2021, 99, 101995. [CrossRef]
12. Zhang, Y-Y.; Ju, G-W.; Zhan, J-T. Farmers using insurance and cooperatives to manage agricultural risks: A case study of the
swine industry in China. J. Integr. Agric. 2019, 18, 2910–2918. [CrossRef]
13. Bijman, J.; Biopoulos, C. Farmers’ Cooperatives in The Eu: Policies, Strategies, And Organization. Ann. Public Coop. Econ. 2014,
85, 497–508. [CrossRef]
14. Ma, W.; Abdulai, A. IPM adoption, cooperative membership and farm economic performance. China Agric. Econ. Rev. 2019, 11, 218–236.
[CrossRef]
15. Zhang, S.; Sun, Z.; Ma, W.; Valentinov, V. The effect of cooperative membership on agricultural technology adoption in Sichuan, China. China Econ. Rev. 2020, 62, 101334. [CrossRef]

16. Li, M.; Yan, X.; Guo, Y.; Ji, H. Impact of risk awareness and agriculture cooperatives’ service on farmers’ safe production behaviour: Evidences from Shaanxi Province. J. Clean. Prod. 2021, 312, 127724. [CrossRef]

17. Ha, T.T.; Bush, S.R.; van Dijk, H. The cluster panacea? Questioning the role of cooperative shrimp aquaculture in Vietnam. Aquaculture 2013, 388, 89–98. [CrossRef]

18. Lin, B.; Wang, X.; Jin, S.; Yang, W.; Li, H. Impacts of cooperative membership on rice productivity: Evidence from China. World Dev. 2022, 150, 105669. [CrossRef]

19. Ortega, D.L.; Bro, A.S.; Clay, D.C.; Lopez, M.C.; Tuyisenge, E.; Church, R.A.; Bizoza, A.R. Cooperative membership and coffee productivity in Rwanda’s specialty coffee sector. Food Secur. 2019, 11, 967–979. [CrossRef]

20. Wossen, T.; Abdoulaye, T.; Alene, A.; Haile, M.G.; Feleke, S.; Olanrewaju, A.; Manyong, V. Impacts of extension access and cooperative membership on technology adoption and household welfare. J. Rural. Stud. 2017, 54, 223–233. [CrossRef]

21. Ankrah Twumasi, M.; Jiang, Y.; Addai, B.; Ding, Z.; Chando, A.A.; Fosu, P.; Asante, D.; Siaw, A.; Danquah, F.O.; Korankye, B.A.; et al. The Impact of Cooperative Membership on Fish Farm Households’ Income: The Case of Ghana. Sustainability 2021, 13, 1059. [CrossRef]

22. Verhofstadt, E.; Maertens, M. Can Agricultural Cooperatives Reduce Poverty? Heterogeneous Impact of Cooperative Membership on Farmers’ Welfare in Rwanda. Appl. Econ. Perspect. Policy 2015, 37, 86–106. [CrossRef]

23. Hailu, G.; Weersink, A.; Minten, B.J. Rural Organizations, Agricultural Technologies and Production Efficiency of Teff in Ethiopia. 2015. Available online: https://ageconsearch.umn.edu/record/211702/ (accessed on 14 September 2015).

24. Ma, W.; Abdulai, A. The economic impacts of agricultural cooperatives on smallholder farmers in rural China. Agribusiness 2017, 33, 537–551. [CrossRef]

25. Mojo, D.; Fischer, C.; Degefa, T. The determinants and economic impacts of membership in coffee farmer cooperatives: Recent evidence from rural Ethiopia. J. Rural. Stud. 2017, 50, 84–94. [CrossRef]

26. Ma, W.; Abdulai, A.; Ma, C. The effects of off-farm work on fertilizer and pesticide expenditures in China. Rev. Dev. Econ. 2018, 22, 573–591. [CrossRef]

27. Abebaw, D.; Haile, M.G. The impact of cooperatives on agricultural technology adoption: Empirical evidence from Ethiopia. Food Policy 2013, 38, 82–91. [CrossRef]

28. Ukaru, A.O.; Uzokwe, U.N.; Ideh, V. Comparative analysis of cooperative and non-cooperative fish farmers in the central agro-ecological zone of Delta State Nigeria. Ext. Farming Syst. J. 2006, 2, 97–104. [CrossRef]

29. Ito, J.; Bao, Z.; Su, Q. Distributional effects of agricultural cooperatives in China: Exclusion of smallholders and potential gains on participation. Food Policy 2012, 37, 700–709. [CrossRef]

30. Bachke, M.E. Do farmers’ organizations enhance the welfare of smallholders? Findings from the Mozambican national agricultural survey. Food Policy 2019, 89, 101792. [CrossRef]

31. Tolno, E.; Kobayashi, H.; Ichizen, M.; Esham, M.; Balde, B.S. Economic analysis of the role of farmer organizations in enhancing smallholder potato farmers’ income in middle Guinea. J. Agric. Sci. 2015, 7, 123. [CrossRef]

32. Li, X.; Ito, J. An empirical study of land rental development in rural Gansu, China: The role of agricultural cooperatives and transaction costs. Land Use Policy 2021, 109, 105621. [CrossRef]

33. Barrett, C.B.; Bachke, M.E.; Bellemare, M.F.; Michelson, H.C.; Narayanan, S.; Walker, T.F. Smallholder Participation in Contract Farming: Comparative Evidence from Five Countries. World Dev. 2012, 40, 715–730. [CrossRef]

34. Poulton, C.; Dorward, A.; Kydd, J. The Future of Small Farms: New Directions for Services, Institutions, and Intermediation. World Development 2010, 38, 1413–1428. [CrossRef]

35. Abdul-Rahaman, A.; Abdulai, A. Do farmer groups impact on farm yield and efficiency of smallholder farmers? Evidence from rice farmers in northern Ghana. Food Policy 2018, 81, 95–105. [CrossRef]