Is Contract Farming with Modern Distributors Partnership for Higher Returns? Analysis of Rice Farm Households in Taiwan

Ming-Feng Hsieh ¹ and Yir-Hueih Luh ²,

¹ Department of Economics, Tunghai University, 1727, Sec. 4, Taiwan Blvd., Xitun Dist., Taichung 407224, Taiwan
² Department of Agricultural Economics, National Taiwan University, 1, Sec. 4, Roosevelt Rd., Taipei 10617, Taiwan
* Correspondence: yirhueihluh@ntu.edu.tw

Abstract: This study provides empirical evidence of the economic effect of contract farming for the agriculture sector dominated by smallholder farms. In light of the association between contract farming and modern food distribution channels, we categorize the adoption decisions of contract farming and modern marketing channels into four mutually exclusive choices and investigate their economic effects through the simulated maximum likelihood estimation of the multinomial treatment effects model. The results provide empirical evidence supporting higher returns from the dual partnerships as choosing modern distributors generates more revenues for those participating in contract farming than for those with no contract farming, and contract farming is more likely to help generate more revenues for those who have taken modern distributors as their major marketing channel compared with those relying on traditional channels. Moreover, we examine whether any distributional pattern of marginal economic effects, of either contract farming or modern marketing channel, is present among farmers at various scales by using the conditional and unconditional quantile regression models. Our findings suggest that the marginal treatment effects are generally in an increasing trend as the quantile increases, implying that the economic effects of contract farming or partnership with modern distributors are more pronounced for higher returns among rice farmers in Taiwan. This finding has great policy implications for developing sustainable agriculture and food supply when facing greater uncertainties due to global warming in the future, especially in an agriculture sector with most smallholder farmers.

Keywords: rice farming; contract farming; modern distributors; multinomial treatment effects; conditional quantile regression; unconditional quantile regression

1. Introduction

Contract farming is an agreement, commitment, and partnership between farmers and other stakeholders in the food supply chain [1–4]. The effects of contract farming on farmers’ productivity, production efficiency, and income has been well documented in the literature both for the developed and developing countries. For example, several important issues concerning contract farming were examined for some developed countries, such as Australia and Taiwan [5,6]. The majority of more recent studies aimed at studying the influences of contract farming for farmers in various developing countries. The research focusing on the economic consequences of contract farming has been deemed a trend and also with compelling reasons [1,7,8]. Some reviews of the economic outcomes of contract farming, for example, [7,8], indicated two issues to be addressed while presenting empirical evidence of benefits associated with contract farming. On the one hand, it was indicated that contract farming results in additional benefits for farmers in developing countries since their farm scale is generally small [8]. This additional benefit is likely to be due to the increase in comparative advantage of small-scale farmers in accessing “higher-end markets”
through contract farming [9]. On the other hand, the economic impacts of contract farming on the farm income, especially for the smallholder farmers, have been mixed, depending on differing production scales and commodity focus [7]. Such disparities between conceptual and empirical findings motivate the present study for further exploration.

This article investigates the effect of contract farming on the sales revenue of the rice producers in Taiwan, to address the two issues mentioned above. The motivation for this study is twofold. First, the issue of lower accessibility of farmers small in production scale, compared with their large counterparts, is an issue common in both the developed and developing worlds since small farmed area constitutes a major constraint for the agriculture sector regardless of a country’s economic development. Second, while some view contract farming as some kind of institutional innovation that can reduce smallholders’ transaction costs and market risks [10], some hold the view that contract farming assists the modernization of smallholder farmers [8]. The economic viability of contracting with modern retailers, such as supermarkets, hypermarkets, retailers (restaurants, fast food chains), and food processors, has been increasing in the process of modernization in the agriculture sector [6,11]. Provision of quality rice meeting food safety standards or high-quality FFVs, in terms of their appearance, shape, size, etc., represents local supermarkets’ response to consumer needs and strategy to compete with traditional markets [12]. In light of the association between contract farming and modern food distribution channels pinpointed in previous studies, for example [13], we also intend to examine the following hypotheses: whether contract farming paired with modern food retailers can increase farmers’ sales revenue and whether such a dual partnership has different economic impacts on farmers varying by their sales revenue.

This study makes three primary contributions to the existing body of knowledge. Our first contribution concerns providing empirical evidence of the economic effect of contract farming for the agriculture sector characterized by smallholder farms. Although there has been a rising trend in the practice of contract farming in developed countries including the US, Western Europe, and Japan [14], empirical evidence in support of the economic influences of contract farming, especially that with modern food distributors, for small-scale farmers in developed countries, is as of yet largely unavailable. Taking Japan as an example, the average farm size per commercial farm in Japan increased from 1.9 ha in 2000 to 2.5 ha in 2020 [15]. Japan’s farmland area per farm is generally larger than many developed countries in which farmers face even more severe farmland constraints. As for Taiwan, the majority of the farmland area per farm household in Taiwan is less than 1 ha, and about 70% of the farm households operate on land less than 0.8 ha (Figure 1). The dominance of farm households who operate on farmland that is less than 0.8 hectares is prevalent in both the 2010 and 2015 Agricultural Census. Therefore, our study contributes to the extant body of knowledge by providing empirical evidence concerning the effects of contract farming in the agriculture sector dominated by smallholder farms. Second, most previous studies addressing the association between contract farming and modern food distribution channels focused on the economic effects on fresh fruits and vegetables. To the best of our knowledge, attention to rice producers has been quite limited. In order to bridge this knowledge gap, the present study aims at understanding the effects of contracting farming with the modern food distributors for farmers with a commodity focus on rice. More importantly, we address the issue of gaps between conceptual arguments and empirical evidences. While contract farming has long been conceptually thought of as a potential to boost smallholder farmer’s revenues due to the risk sharing with the contractors and for market expansion, there were, however, mixed empirical results in the existing literature. Enlightened by a potential distributional difference in economic effects among farmers, we demonstrate a profound research on the treatment effects of marketing channel choice and contract farming engagement by using more rigorous empirical methodologies including multinomial treatments model and quantile regressions. It is important to investigate how the effects of contract farming and partnership with modern distributors vary by farm scale, especially when the adoption of the two is disproportional for rice
farming in Taiwan. It is an important feature to encourage more sustainable agriculture as the risk factor plays a key role in farmer’s farming decisions facing uncertainties in the future, especially under extreme weather conditions induced by global warming. Hence, we not only contribute to the literature by constructing a solid empirical study for a consistent set of estimates on the treatment effects but also assess an influential policy concern in Taiwan’s agriculture for sustainable farming and adequate food supply.

![Figure 1. Farm size per household from the 2010 and 2015 Agricultural Census.](image)

There are three reasons for our research focus on rice farmers. Firstly, rice has been the major staple food in Asia where the development of supermarkets and hypermarkets has been seen as the emerging trend in the era of economic growth [16]. It was indicated that in some countries, such as Thailand, almost half of the rice consumed by residents in more urbanized cities was purchased from modern marketing channels, including supermarkets, hypermarkets, and convenience stores, etc. [12]. According to the ranking of the Consumer Reach Points (CRPs) of Taiwan’s retail channels for the second quarter of 2020, by Kantar Taiwan (Worldpanel Division), Quanlian supermarket ranked first with 187 million consumer touches with an increase in annual growth rate of 4%, followed by 7-ELEVEN (a branded convenience store) which has nearly 68 million CRPs with a flat annual growth rate, followed by Carrefour Group with nearly 55 million CRPs (6% annual growth rate) [17]. Kantar Taiwan also indicated that the ranking of the sales in food category is similar to that of the overall retail sales. These figures illustrate the important role of organized retailers (supermarkets, hypermarkets, convenience stores) in Taiwanese food purchases. Secondly, it was found in a study in Vietnam [18], that the low perishability of rice and consumers’ lower concern over rice safety lead to different marketing channel distributions for rice and the fresh fruits and vegetables with the former relying more on wholesalers. However, contrary to what was observed in Vietnam, there are approximately 73.6% of rice farm households relying on modern distributors, including supermarkets, hypermarkets, convenience stores, processors, etc., as the major marketing channels in Taiwan. Thirdly, participation rate of contract farming is still low [6] since the government launched a production–marketing program in 2005, whereas rice is one of the top three contract farming commodities in Taiwan with a share of 5.59% out of 26,563 rice farmers participating in contract farming with food distributors (Table 1).
Table 1. Frequency and percentage of contract farming.

| Commodity Focus   | No. of Obs. | No Contract Farming | Contract Farming |
|-------------------|-------------|---------------------|------------------|
| Rice              | 26,563      | 94.41%              | 5.59%            |
| Sundry            | 3661        | 86.42%              | 13.58%           |
| Special crops     | 8509        | 96.51%              | 3.49%            |
| Vegetables        | 34,896      | 96.95%              | 3.05%            |
| Fruits            | 61,674      | 98.93%              | 1.07%            |
| Mushrooms         | 782         | 98.98%              | 1.02%            |
| Sugarcane         | 116         | 90.52%              | 9.48%            |
| Flowers           | 2975        | 95.19%              | 4.81%            |
| Other crops       | 1730        | 97.80%              | 2.20%            |
| Livestock         | 4690        | 91.11%              | 8.89%            |
| Poultry           | 3272        | 59.20%              | 40.80%           |
| Other raising     | 123         | 100.00%             | 0.00%            |

Source: The primary farm household survey (PFHS).

This paper is organized as the following way. We delineate the farm household data and the econometric model used in this study in the next section, followed by the section presenting and discussing the results. The conclusion section summarizes the major findings in this article, in which we also propose the direction for possible extension in the future.

2. Materials and Methods

2.1. The Farm Household Data

Our rice producers’ data is drawn from the 2013 Primary Farm Household Survey (PFHS). The primary farm households are randomly selected from the Agricultural Census based on two criteria: (1) making an annual income of more than NTD 200,000; and (2) at least one member working on the farm is under 65 years old (NTD, short for New Taiwanese Dollar, was exchanged at a rate of 0.0337 USD on average during 2013 when the PFHS was conducted). In the PFHS, farm households are categorized by their commodity focus which takes the highest share in total farm revenue from the farm produce that are not processed. Farm households whose major sales revenue is from rice are selected. There are 26,563 rice farm households in our final data set after rescaling by the sample weights.

The variable definition and descriptive statistics of the rice farm households are listed in Table 2. The average level of annual farm sales revenue is around NTD 740,000, which is around USD 25,000. Primary farm households participating in contract farming are approximately 4% \[6\]. Rice households participating in contract farming are about 6%. Following a broader definition of modern food distributors \[19\], we define modern food distributors as supermarkets, hypermarkets, convenience stores, brand stores, restaurants, and processors, which take around 74% of the rice farm households.

Approximately 88% of the principal operators of rice farm households are male. The average age of the rice farm operators is 61 years old, about two years older than the average of farm operators in the PFHS data. Principal operators’ educational levels are most with elementary school and below (55%), while the rest are with junior high (23%), senior high (17%), and college degree and above (5%). On average, principal operators in the rice households have approximately 33 years of farming experience. About 42% of the farm operators do not have work experience before farming. Those having previous work experience are: 42% worked in the secondary and tertiary industries or were government employees, 11% self-employed, and 5% agriculture-related work.

The household’s own and hired labor are around 2.62 and 0.02, which indicate that the majority of the rice farm households rely on their own household members. The average farmland area of rice farms is about 1.2 hectare. While the geographical distribution of the primary farm households is central (45%), south (35%), north (15%), and east (5%), there are more rice farm households located in central Taiwan (53%) than in the south (35%), the east (7%), and the north (6%).
Table 2. Variable definition and descriptive statistics.

| Variable         | Definition                                                                 | Mean   | Std. Dev. |
|------------------|-----------------------------------------------------------------------------|--------|-----------|
| Revenue          | Sales revenue from fresh produce (in thousand NTDs)                         | 520.88 | 633.61    |
| Contract Farming | Contract farming, yes = 1, no = 0                                          | 0.06   | 0.23      |
| Modern retailer  | Supermarkets, hypermarkets, retailers, processors, etc., yes = 1, no = 0   | 0.74   | 0.44      |
| Male             | Male operator, yes = 1, no = 0                                              | 0.88   | 0.33      |
| Age              | Operator’s age, 22–92                                                      | 61.50  | 10.61     |
| Elementary       | Elementary school degree and below, yes = 1, no = 0                         | 0.55   | 0.50      |
| Junior high      | Junior High school, yes = 1, no = 0                                         | 0.23   | 0.42      |
| Senior high      | Senior High school, yes = 1, no = 0                                         | 0.17   | 0.37      |
| University       | College degree and above, yes = 1, no = 0                                   | 0.05   | 0.23      |
| Experience       | Years of farming experience                                                | 33.36  | 14.95     |
| Agriculture      | Previous work: agriculture, yes = 1, no = 0                                 | 0.05   | 0.22      |
| 2nd and 3rd industry | Previous work: secondary and tertiary industries, yes = 1, no = 0     | 0.42   | 0.49      |
| Self-employed    | Self-employed, yes = 1, no = 0                                             | 0.11   | 0.32      |
| No previous work | No previous work experience, yes = 1, no = 0                                | 0.42   | 0.49      |
| Farm workdays    | Farm operators’ on-farm workdays                                           | 141.46 | 77.90     |
| Own labor        | Number of household members working on the farm                            | 2.62   | 1.00      |
| Hired labor      | Number of hired works                                                       | 0.02   | 0.36      |
| Farmland         | Farmland size in area (0.01 ha)                                            | 119.29 | 90.64     |
| North            | Farm household located in northern Taiwan, yes = 1, no = 0                  | 0.06   | 0.23      |
| Central          | Farm household located in central Taiwan, yes = 1, no = 0                   | 0.53   | 0.50      |
| South            | Farm household located in southern Taiwan, yes = 1, no = 0                  | 0.35   | 0.48      |
| East             | Farm household located in eastern Taiwan, yes = 1, no = 0                   | 0.07   | 0.26      |

Source: The primary farm household survey (PFHS).

We present the by-group descriptive statistics in Table 3. In general, farm households that participate in contract farming outperform those that do not participate in contract farming in terms of sales revenue from farm produce by about 90.8% on average. Principal farm operators that participate in contract farming are younger, with fewer years of farm experience and have a higher educational level (junior high or above). Furthermore, the farm households adopting contract farming have more farm workdays, more hired workers, larger farmland areas, and are disproportionately located in East Taiwan, which is famed for its natural and recreational scenery and especially with much less pollution due to its low degree of industrialization and urbanization.

Table 3. By-group descriptive statistics.

| Variable                | No Contract Farming | Contract Farming |
|-------------------------|---------------------|------------------|
| Revenue                 | 495.6904            | 945.9314         |
| Modern retailer         | 0.7431              | 0.6157           |
| Male                    | 0.8734              | 0.9307           |
| Age                     | 61.9295             | 54.1999          |
| Elementary              | 0.5734              | 0.1931           |
| Junior high             | 0.2188              | 0.3318           |
| Senior high             | 0.1569              | 0.3661           |
| University              | 0.0509              | 0.1090           |
| Experience              | 33.7738             | 26.2934          |
| Agriculture             | 0.0518              | 0.0377           |
| 2nd and 3rd industry    | 0.4148              | 0.4711           |
| Self-employed           | 0.1168              | 0.0582           |
| No previous work        | 0.4167              | 0.4361           |
| Farm workdays           | 136.1281            | 231.4603         |
Table 3. Cont.

| Variable     | No Contract Farming | Contract Farming |
|--------------|---------------------|------------------|
|              | Mean    | Std. Dev. | Mean    | Std. Dev. |
| Own labor    | 2.6561  | 0.9971   | 2.0128  | 0.8444   |
| Hired labor  | 0.0128  | 0.2349   | 0.1837  | 1.1775   |
| Farmland     | 115.9513 | 80.2865 | 175.7073 | 186.3568 |
| North        | 0.0611  | 0.2394   | 0.0020  | 0.0449   |
| Central      | 0.5490  | 0.4976   | 0.1225  | 0.3279   |
| South        | 0.3559  | 0.4788   | 0.1824  | 0.3863   |
| East         | 0.0341  | 0.1815   | 0.6931  | 0.4613   |
| No. of observations | 25,077 |       | 1486    |         |

Source: The primary farm household survey (PFHS).

2.2. Empirical Specification

We categorize the adoption decisions of contract farming and modern marketing channels into four mutually exclusive choices: (1) choice = 1 (does not participate in either contract farming or modern marketing channels); (2) choice = 2 (participate in contract farming but not modern channels); (3) choice = 3 (participate in modern channels but not contract farming); (4) choice = 4 (participate in both contract farming and modern channels).

The “mtreatreg” module in STATA is used to test for our working hypothesis: whether contract farming paired with modern food retailers can contribute to higher revenue for farm households with a commodity focus on rice. The estimation of the multinomial treatment effects (MTE) model using the simulated maximum likelihood algorithm has been widely applied in the field of agricultural economics. The advantages of application of the MTE model are mainly due to the design of the model taking the endogenous treatment effects of choice variables (contract farming and/or partnership with modern distributors) into consideration when performing the regression of outcome variable (sales revenue or profit). It would lead to relatively more consistent or unbiased estimates compared to regressions without controlling for the treatment effects. For example, the MTE model was used to investigate the economic outcomes of Indian farmers’ choice of marketing channels [20]. To measure the effects of adopting contract farming and modern food distribution channels, we control for farm household characteristics including major operators’ gender, age, educational level, years of farming experience, farmland area, hired labor, and household labor. In comparison, we also run an OLS (ordinary least squares) regression without controlling for the treatment effects, in which an interaction term of the two choice variables—participating in contract farming and using modern food distribution channels—is included along with the two choice variables and other explanatory variables (base specification).

The limitation of such an empirical approach, along with many other treatment effects models, is that it exhibits only the conditional mean estimates but not conditional quantile estimates of marginal effects of the treatment effects. A preliminary analysis of the sales revenue for farm households adopting different production and marketing strategies is analyzed through Figure 2. It is demonstrated in Figure 2 that differences in sales revenue corresponding to farmer’s choice of production/marketing strategies as well as distributional differences along the revenue distribution exist. Hence, we estimate conditional quantile regressions (CQR) [21] with the above base specification to obtain the impacts estimated on the conditional quantiles instead of on the conditional mean. We also adopt a so-called unconditional quantile regression approach (UQR) proposed by [22] based on the re-centered influence function (RIF) of unconditional quantile on the explanatory variables to estimate the direct effect of increasing the proportion of contract farming and/or with modern distributor partnership on the various quantile of the distribution of sales revenues. Such an approach has also been applied in the literature examining heterogeneous effects of various farming choices or strategies, e.g., organic adoption [23], cooperative membership [24], governmental policy support [25], rural infrastructure [26],
and Internet use [27] on farm household performance or well-being. Our UQR estimation is conducted with the module of “uqreg” in STATA, in which point estimates of average treatment effects were provided to capture the “unconditional quantile partial effects (For the details of the STATA module, please refer to [28]).

![Figure 2](image_url)

**Figure 2.** Mean revenue differences along the revenue distribution by adoption category: (a) choice = 3 (participate in modern channels but not contract farming); (b) choice = 2 (participate in contract farming but not modern channels); (c) choice = 1 (does not participate in either contract farming or modern marketing channels); (d) choice = 4 (participate in both contract farming and modern channels). Source: The primary farm household survey (PFHS).

### 2.3. Identification Strategy

We assume that the principal farm operator’s choice of the production/marketing strategies is a rational behavior intended to maximize farm household’s expected utility as in previous work (see, for instance, [29]).

Let the vectors of the farm operator’s observed characteristics and the corresponding parameters be denoted by, respectively, x and α. The farm operator’s choice of production/marketing strategies is indicated by choice\(_k\) \((k = 1, 2, 3, 4)\). That is, choice\(_1\) takes the value of 1 when the farm household participates in contract farming and takes modern food distributors as the major marketing channel and 0 otherwise. The other three dummy variables are similarly defined as choice\(_2\) = 1 if the farm household participates in contract farming but not modern channels; choice\(_3\) = 1 if the farm household participates in modern channels but not contract farming; and choice\(_4\) = 1 if the farm household participates in both contract farming and modern channels.

We assume the farm operator’s expected utility associated with choice\(_m\) is a linear function of the farm household’s and principal operator’s characteristics, x. That is, the \(i\)th farm operator’s expected utility is given by:

\[
E_i(\pi^m) = x_i\alpha_m + \varepsilon_{im}, \quad m = 1, \ldots, 4.
\]  

(1)
Under the assumption that the disturbance terms, $\varepsilon_{i1}, \ldots, \varepsilon_{i4}$, follow a multinomial logistic distribution, the $i$th farm operator’s probability of choosing the $m$th strategy can be expressed as:

$$\text{Prob}[\text{choice}_{im} = 1 | x, w, \alpha, \theta] = \frac{\exp(x_i \alpha_m + s_i \beta_m)}{1 + \sum_{j=1}^{4} \exp(x_i \alpha_j + s_i \beta_j)}, \ m = 1, \ldots, 4. \ (2)$$

In the above equation, $s$ and $\beta$ are vectors of the latent variables and their corresponding parameter vector. This study then starts out with the outcome equation of the farm operator’s crop choices.

The sales revenue is determined by the choice of the production/marketing strategies as the following,

$$R_i = \gamma_0 + \gamma_1 \text{choice}_{i1} + \gamma_2 \text{choice}_{i2} + \gamma_3 \text{choice}_{i3} + \gamma_4 \text{choice}_{i4} + x_i \kappa + \mu_i. \ (3)$$

$R_i$ in the above equation denotes farm household $i$’s sales revenue from rice farming. The parameter vector corresponding to the socioeconomic characteristics that affect farm household’s sales revenue is denoted by $\kappa$.

In light of the endogeneity problem associated with the estimation of (3), the outcome equation to be estimated with (2) through the maximum simulated likelihood is what follows:

$$E(R_i | x, \text{choice}, l^*, \kappa, \lambda) = \theta_0 + x_i \kappa + \theta \text{choice}_i + l^*_i \lambda. \ (4)$$

In the above specification, $l^*$ is the latent factor vector that represent the unobservable characteristics determining both the farm household’s sales revenue and the choice of production/marketing strategies based on the underlying preferences ($C^*$), while $\lambda$ denotes the vector of the selectivity correction terms [30].

In conditional quantile regression (CQR) for the $\tau$th-quantile, it is assumed that the $\tau$th-conditional quantile of the dependent variable is given as a linear function of the explanatory variables:

$$q_\tau = Q(R_i | x, cf, md, C^*, \kappa, \beta) = \theta_0 + x_i \kappa + \beta_1 cf_i + \beta_2 md_i + \beta_3 (cf * md)_i, \ (5)$$

where $cf_i$ takes the value of 1 when the $i$th farm household participates in contract farming and 0 otherwise; $md_i$ takes the value of 1 when choosing modern food distributors as the major marketing channel and 0 otherwise; and their interaction term $(cf * md)_i$, and $q_\tau = Q(\cdot | X)$ denotes the $\tau$th quantile of $Y$ (sales revenue) conditional on $X$. It is easy to see that the various combinations of the above three terms will reproduce the multinomial choice of production/marketing strategies indicated by choice in the previous model incorporated with treatment effects.

The approach of unconditional quantile regression (UQR) builds on the concept of the influence function $\text{IF}(Y; q_\tau, F_Y) = (\tau - 1\{Y \leq q_\tau\})/f_Y(q_\tau)$. In the so-called recentered influence function (RIF) regression model by [24], the dependent variable for the given quantile is:

$$\text{RIF}(Y; q_\tau, F_Y) = q_\tau + (\tau - 1\{Y \leq q_\tau\})/f_Y(q_\tau). \ (6)$$

It is shown in the study, [22], that the marginal effect of increasing the proportion of a treatment on the $\tau$th-quantile of the distribution of the outcome variable is captured by the UQR estimates rather than CQR estimates. The estimation of the marginal effect on the unconditional quantile is performed by computing the average derivative of the unconditional quantile regression within a small derivation from the specific point in the distribution of covariates, holding everything else constant.

3. Results and Discussion

The results are divided into the following subheadings. First, the results from the multinomial treatment–effect model are presented in Section 3.1, with a comparison to the
OLS results. Section 3.2 documents the differential effects at different points of the outcome distribution for conditional and unconditional quantile regression estimation. The three versions of estimation for identifying treatment effects of contract farming and/or modern distributors on sales revenue for rice farm households are compared and further discussed in Section 3.3.

3.1. Multinomial Treatment Effects

Table 4 reports the estimation results from the MTE and the OLS models. In the MTE’s estimates, the results show that the farm households with choice₁ (no contract farming and traditional distributors) received less sales revenues by NTD 115,270 in comparison with the base category—the ones with choice₃ (no contract farming and modern distributors), implying that choosing modern distributors as the major marketing channel would produce positive outcomes in sales revenue.

Table 4. MTE and OLS regression results.

| Variable          | (1) MTE | Variable          | (2) OLS |
|-------------------|---------|-------------------|---------|
| choice₁           | −115.27 *** | choice₁           | −91.50 *** |
| choice₂           | 11.68   | choice₂           | −12.13  |
| choice₄           | 186.72 *** | choice₄           | 144.13 *** |
| Male              | −13.25 **  | Male              | −9.92 *  |
| Age               | −8.27 ***  | Age               | −8.40 *** |
| Elementary        | 24.62 **  | Elementary        | 26.00 ** |
| Junior high       | 14.25    | Junior high       | 15.99   |
| Senior high       | 6.17     | Senior high       | 6.40    |
| University        | 3.52 ***  | University        | 3.59 *** |
| Experience        | 106.02 *** | Experience        | 102.11 *** |
| Agriculture       | −60.48 *** | Agriculture       | −58.22 *** |
| 2nd and 3rd industry | −156.51 *** | 2nd and 3rd industry | −155.08 *** |
| Self-employed     | 2.03 ***  | Self-employed     | 2.03 *** |
| Own labor         | 84.12 *** | Own labor         | 83.81 *** |
| Hired labor       | 182.28 *** | Hired labor       | 183.15 *** |
| Farmland          | 1.62 ***  | Farmland          | 1.61 *** |
| North             | 36.79 *   | North             | 29.56   |
| South             | −27.09 *** | South             | −24.22 *** |
| East              | 12.92     | East              | 36.88   |
| Constant          | 276.70 *** | Constant          | 181.79 *** |
| Observations      | 26,563   | Observations      | 26,563  |
| $\lambda_1$       | 27.77 *** | $R^2$             | 0.217   |
| $\lambda_2$       | −26.65 ***|                   |         |
| $\lambda_4$       | −57.35 ***|                   |         |
| sigma             | 556.53   |                   |         |

Note: Statistical significance levels *** $p \leq 0.01$; ** $p \leq 0.05$; * $p \leq 0.1$. The base category for MTE regression is choice, the farmers with no contract farming but modern distributors.

This result is consistent with a previous study which also found the positive economic effect of using modern food channels, e.g., [31]. Similarly, we found a positive average treatment effect for contract farming which concurs with the conclusion of a positive effect of contract farming in the systematic review of the economic effects of contract farming in 13 developing countries [2]. Model (1) in Table 4 also shows that the farm households with choice₄ (contract farming and modern distributors) received more sales revenues by NTD 186,720 in comparison with the base category; that is, contract farming with modern food distributors brings more revenues to the farm households after taking both treatment effects into account. Relative to contract farming with traditional food distributors, our finding of additional benefits associated with contract farming and modern food distributors concurs with the results found in previous studies, for example [32].
Beyond the choice variables, the farm households with male principal operators, the self-employed, with more own labor or having bigger farmland size, tend to have higher sales revenues, while age and prior experience in agricultural, industrial (second), or service (third) sectors present as negative factors to a farmer’s sales revenue. It shows a generally consistent set of estimation results from the two models in terms of the directions and scales of coefficient estimates for those control variables. However, it is worth noting that the estimates of the selectivity coefficients ($\lambda_1$, $\lambda_2$, $\lambda_4$) to the latent factor vector, which represent the unobservable characteristics determining both farm household’s sales revenue and the choice of production/marketing strategies based on the underlying preferences, are significantly different from zero. It implies that the MTE estimates are relatively more consistent or unbiased than the OLS estimates.

To further investigate the marginal effects of either choice when holding the other the same, we compute the linear combinations of associated coefficients after the MTE and the OLS regression estimation. As shown in Table 5, the marginal effects estimated from the MTE model are generally greater than the OLS estimates, suggesting that the least square estimates tend to underestimate the effects of choice variables due to the lack of controlling for the endogeneity of treatment choices.

Table 5. Marginal effects of contract farming or modern distributors.

| Marginal Effect of Contract Farming | Traditional Distributors | Modern Distributors |
|-----------------------------------|--------------------------|---------------------|
| MTE                               | OLS                      | MTE                 | OLS                 |
| 126.95 ***                        | 79.37 *                  | 186.72 ***          | 144.13 ***          |
| (43.77)                           | (43.42)                  | (34.36)             | (34.93)             |

| Marginal Effect of Modern Distributors | No contract Farming | Contract Farming |
|----------------------------------------|---------------------|------------------|
| MTE                                    | OLS                 | MTE              | OLS                |
| 115.27 ***                             | 91.50 ***           | 175.04 ***       | 156.27 ***         |
| (9.42)                                 | (7.72)              | (61.07)          | (59.89)            |

Note: Statistical significance levels *** $p \leq 0.01$; ** $p \leq 0.05$; * $p \leq 0.1$.

While controlling for the choice of marketing channels, the marginal effect estimates indicate that contract farming contributes to sales revenue by a greater scale between the ones with modern distributors, in comparison between those with traditional distributors. On the other hand, choosing modern distributors as the major marketing channel shows a positive impact on the sales revenue regardless of whether participating in contract farming but with a bigger scale of impact for those who participated in contract farming than the ones that did not. Take the MTE estimates. The marginal effect of contract farming for the farmers partnered with modern distributors is on average 47% more than the one for farmers with traditional distributors. Between the farmers with and without contract farming, the MTE estimate of marginal effect of partnership with modern distributors for those adopting contract farming is about 52% more compared to those with no contract farming. This presents an interesting picture regarding the economic effects of adopting the two choices, in which choosing modern distributors generates more revenues for those with no contract farming (94% of the analysis sample), and even more for the farmers with contract farming (the rest 6%); additionally, contract farming is more likely to help generate more revenues for those who have taken modern distributors as their major marketing channel—consisting of 74% observations in our analysis sample. These results from both the MTE and the OLS models suggest that contract farming in partnership with modern distributors boosts more sales revenues for rice farmers.

Such results could also correlate to the distributional patterns that we observed in Figure 2, where contract farming makes significantly positive differences in revenues at the higher quantiles of the revenue distribution, while choosing modern distributors reduces the sales revenues towards the higher quantile of the revenue distribution. This calls
for further investigations on the conditional (or unconditional) quantiles of the response variable rather than on the conditional means as performed in the above.

3.2. Conditional and Direct Effects from Quantile Regressions

We demonstrate the distributional differences in the effects of the determinants on farmer’s sales revenue at low (q10), median (q50), and high (q90) quantiles from both conditional and unconditional quantile regressions in Table 6. As illustrated in Section 2.3, the coefficient estimates from the CQR are generally different from the ones from the UQR, especially when the explanatory variable is binary as the choice of contract farming (cf) or modern distributors (md) in our analysis. In our case study, the unconditional quantile regression’s coefficient estimates are generally greater in size in comparison to the ones from conditional quantile regression as in Table 6. For instance, farmers choosing modern distributors as their major marketing channel have generated higher sales revenues compared to the ones with traditional distributors, and the effects increase with the quantiles evaluated. In addition, the direct effects estimated from the UQR are larger than the conditional effects from the CQR. Taking the 90th percentile, the UQR’s estimate of marginal effect of a partnership with modern distributors (for those who do not adopt contract farming) is 437.32, while the CQR’s is only 82.15 more in sales revenue (in thousands of NTD). Between quantiles, there are also significant differences in marginal effects. Take uq90 and uq50 as a comparison; the marginal effect of a partnership with modern distributors for non-contract-farming households is four times the median (50th) at the 90th quantile. Similarly, in comparison to the MTE estimate, the specific UQR’s 90-th quantile estimate (437.32) is about 3.78 times of the mean effect (115.27). Such patterns of distributional effects are also observed in most coefficient estimates for most control variables. More sizable marginal effects of other explanatory variables on sales revenue in unconditional quantile estimates than in conditional quantile ones are also observed. Generally, we observe negative associations of age and prior experiences with farmer’s sales revenue throughout the distribution, while holding other variables constant.

Table 6. Conditional and unconditional quantile regression results.

| Variable                  | (1) Conditional Quantile Regression | (2) Conditional Quantile Regression | (3) Conditional Quantile Regression | (4) Unconditional Quantile Regression | (5) Unconditional Quantile Regression | (6) Unconditional Quantile Regression |
|---------------------------|------------------------------------|------------------------------------|------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|
|                           | cq10                               | cq50                               | cq90                               | uq10                                 | uq50                                 | uq90                                 |
| contract farming (cf)     | 54.69 ***                          | 24.21 **                           | −125.76                            | 47.99                                 | 80.38                                | 7.64                                 |
| modern distributors (md)  | 5.52 ***                           | 20.46 ***                          | 82.15 ***                          | 16.71                                 | 106.94 ***                           | 437.32 ***                           |
| interaction (cf * md)     | 28.85 ***                          | 212.17 ***                         | 343.31 ***                         | 26.18                                 | 72.97                                | 619.98                               |
| Male                      | −49.96 ***                         | −42.55 ***                         | 51.20 ***                          | 26.70                                 | 34.42                                | 464.56 *                             |
| Age                       | −1.17 ***                          | −3.64 ***                          | −9.48 ***                          | −0.58                                 | −4.36 ***                             | −28.48 ***                           |
| Elementary                | −46.07 ***                         | −18.77 ***                         | 49.22 **                           | 17.91                                 | 31.34                                | 102.48                               |
| Junior high               | −0.68                              | 0.48                               | 44.87 *                            | 19.74                                 | 45.51                                | 183.02                               |
| Senior high               | −22.76 ***                         | −13.5                              | −45.16                             | 34.23                                 | −25.19                                | −439.15                              |
| University                | −0.07                              | 0.98 ***                           | 5.67 ***                           | 0.89                                  | 2.88 **                               | 0.52                                 |
| Experience                | −37.17 ***                         | −39.20 ***                         | −43.27                             | −12.62                                | 8.14                                 | −397.07                              |
| Agriculture               | 0.89                               | 12.94 ***                          | −29.00                             | −50.49 ***                            | −47.57 *                              | −677.50 ***                           |
| 2nd and 3rd industry      | −63.89 ***                         | −37.70 ***                         | −93.58 ***                         | −64.12 ***                            | −131.42 ***                           | −915.56 ***                           |
| Self—employed             | 0.01                               | 0.86 ***                           | 4.31 ***                           | −0.05                                 | 1.00 ***                              | 6.45 ***                              |
| Own labor                 | −7.59 ***                          | 10.49 ***                          | 13.82                              | 5.97                                  | 52.65 ***                             | 406.53 ***                           |
| HIred labor               | −4.62                              | 72.02                              | 307.43                             | −29.73 ***                            | −29.51 *                              | 118.03                               |
| Farmland                  | 0.97 ***                           | 1.43 ***                           | 1.91 ***                           | 0.20 ***                              | 0.63 ***                              | 2.81 ***                              |
| North                     | −44.10 ***                         | −71.77 ***                         | 128.69 ***                         | −70.04 ***                            | −42.17                                | 648.11 ***                            |
| South                     | −16.83 ***                         | −10.45 ***                         | −9.80                              | 38.18 ***                             | 70.26 ***                             | 54.83                                 |
| East                      | −78.08 ***                         | −78.72 ***                         | 234.61 ***                         | −40.35 *                              | −7.82                                 | 229.90                               |
| Constant                  | 305.57 ***                         | 306.03 ***                         | 250.03 ***                         | 26563                                 | 26563                                 | 26563                                 |

Observations: 26,563 26,563 26,563 26,563 26,563 26,563

Note: Statistical significance levels *** p ≤ 0.01; ** p ≤ 0.05; * p ≤ 0.1.
To further decompose the treatment effects, we compute the marginal effects of contract farming or modern distributor partnership when keeping the other constant by linear combinations of coefficient estimates from the CQR and the UQR at the quantiles between the 5th–95th percentiles. Figure 3 compares the associated marginal effects from the OLS, multinomial treatment effects (MTE), conditional (CQR), and unconditional quantile regressions (UQR). Chart (a) shows no statistically significant effect of contract farming on sales revenue between the farmers partnered mainly with traditional distributors.

Figure 3. Marginal effects of contract farming or channel choice (modern/traditional) on revenue. Note: The associated marginal effects are computed by linear combinations of coefficient estimates from various models. The black dash (−−) line represents the OLS estimates, the blue dash-dot (−−.) line represents the estimates from the multinomial treatment–effect model, the green solid line (−−) represents the CQR estimates with 95% confidence intervals in green dot lines (⋯), and the red solid line (−−) represents the UQR estimates with 95% confidence intervals in gray shaded areas at various quantiles between the 5th and 95th percentiles.

As shown in Figure 3, we observe generally larger effects of contract farming between the farmers partnered mainly with modern distributors, and both the CQR estimates and the UQR estimates of marginal effects increase as quantile increases, even though the variation becomes larger too (chart (b)). The marginal effects of partnering with modern distributors on sales revenue are generally positive and increasing as the quantile increases.
between non-contract-farming farmers (chart (c)) or between contract-farming farmers (chart (d)). There are noticeably greater marginal effects of partnership with modern distributors at higher quantiles (75th or above) regardless of the farmer’s contract farming choice.

In sum, the effects estimated from the conditional or unconditional quantile regression provide a vivid image on how the changes in the quantiles of the marginal distribution of outcome variable, i.e., sales revenue in our analysis. The marginal treatment effects vary by the distribution of sales revenue, generally in an increasing trend as the quantile increases.

3.3. A Remark on the Determinants and Distributional Effects on Profit

In addition, we also conduct analyses on the determinants and distributional effects of contract farming and channel choice on the profit of rice farm households in Taiwan. The results are generally similar to the ones for sales revenue of rice farm households. The estimates based on the conditional means, including the MTE and the OLS models, resemble the results from the revenue equations. One of the noticeable differences between the profit and sales revenue estimation results is a downturn in marginal effects of the two production/marketing choice variables at the high quantiles of the distribution. As shown in Appendix A, the marginal (direct) effects of either choice on profit from the unconditional quantile regression are positive and increasing as the quantile increases but become insignificantly different from zero or even go into the negative territory at the high quantiles (85th–95th percentiles) of profit distribution, especially for the cases when farmers already adopt one of the two choices (contract farming or modern distributors). It implies that adopting one additional production or marketing strategy may generate more sales revenue on one hand but could hinder a farmer’s profit for those in the higher quantiles of the distribution likely associated with additional costs corresponding to such dual partnerships.

4. Conclusions

We provide a comprehensive exploration of the economic effects of farm households’ production and marketing strategies. Specifically, this study focuses on investigating the effect of contract farming on the sales revenue of rice producers in Taiwan. In light of the important role of supermarkets, hypermarkets, and convenience stores in Taiwanese food purchases and the emerging trend of farmers’ contract farming with modern food distribution channels, we also examine if contract farming with modern food retailers can increase farmers’ sales revenues.

There have been mixed empirical results on the economic impacts of contract farming on farm income, especially for the smallholder farmers in the existing literature, even though contract farming has been thought beneficial to small-scale farmers for being able to provide access to higher-end markets. Such mixed results may be due to biased estimates due to the design of the empirical approach. In our present study, we apply both the multinomial treatment effects model and quantile regression models to assess both mean treatment effects and marginal effects over the quantiles in a distribution of sales revenue. We believe that such methodological efforts are proven to bring more understanding and insights on how contract farming as well as partnership with modern distributors impact farmers’ profitability at various scales. It resolves the puzzle of mixed results being observed in the previous studies, as the marginal effects of contract farming vary by their profitability scale.

Our major findings are summarized as the following. First, the marginal effect estimates from the MTE model indicate that contract farming contributes positively to sales revenue regardless of their channel choice, but more between the ones with modern distributors than between those with traditional distributors. This result is consistent with previous studies’ findings that farmers participating in contract farming with modern food distributors outperform those who do not. Second, the results from the conditional and unconditional quantile regression provide a vivid image that treatment effect changes in
the quantiles of the marginal distribution of sales revenue—the marginal treatment effects vary by the distribution of sales revenue, generally in an increasing trend as the quantile increases. Although it is shown that the partnership of contract farming with modern food distributors could boost more sales revenues for rice farmers based on the results from both MTE and quantile regressions, it may limit farmers’ ability to gain profit for those in the higher quantiles of the distribution from the quantile estimations.

While the ratio of partnership with modern retailers has been high (with an average of 74%), the contract farming rate accounts for only 6% among rice farmers in Taiwan. Through quantile regressions, especially the UQR approach, we show that the marginal effects of contract farming are positive and higher for those who have partnerships with modern distributors, especially at higher quantiles. It implies that contract farming paired with modern distributors has the potential to boost farmer’s revenues by risk sharing with the contractors and extending markets with modern distributors. It is an important feature to encourage more sustainable agriculture as the risk factor plays a key role in farmers’ decision making when facing a greater degree of uncertainty from global warming, especially for an agriculture with smallholders in Taiwan or some South Asian countries and many developing countries. The more income security, the more sustainable agriculture will be.

There are two major research limitations of the present study. Our first research limitation concerns the data availability. Although the PFHS is a dated set of data, it is the most-up-to-date available and a representative set of data that fits for the present subject of interest. For one thing, the data are lack of the proportion of contracted farm produce in the farm households’ total sales. Therefore, how the treatment effect varies with farmers’ degree of contract farming participation was not examined. Another shortcoming of the data is that some details of contract farming were not recorded. One of the unobserved information is the type of contract, and different contracts may vary in their economic impacts on farming outcomes. Therefore, where data permit, future research may seek to identify and compare the economic effects of different types of contract farming, including spot contracts, contracted production, contracted sale, and management contacts in vertical integration.

**Author Contributions:** Conceptualization, Y.-H.L.; data curation, M.-F.H. and Y.-H.L.; formal analysis, M.-F.H. and Y.-H.L.; funding acquisition, Y.-H.L.; investigation, M.-F.H. and Y.-H.L.; methodology, M.-F.H. and Y.-H.L.; project administration, Y.-H.L.; resources, Y.-H.L.; software, M.-F.H. and Y.-H.L.; supervision, Y.-H.L.; validation, Y.-H.L.; visualization, M.-F.H. and Y.-H.L.; writing—original draft, M.-F.H. and Y.-H.L.; writing—review and editing, M.-F.H. and Y.-H.L. All authors have read and agreed to the published version of the manuscript.

**Funding:** Part of this research is funded by the National Science and Technology Council (previously, Ministry of Science of Technology) in Taiwan under project number MOST-106-2410-H-002-018.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** The data used in this study are available from the Survey Research Data Archive, Center for Survey Research, Academia Sinica, through application.

**Conflicts of Interest:** The authors declare no conflict of interest.
Appendix A. Marginal Effects of Contract Farming or Channel Choice (Modern/Traditional) on Profits

Figure A1. Marginal effects of contract farming or channel choice (modern/traditional) on profits. Note: The associated marginal effects are computed by linear combinations of coefficient estimates from various models. The black dash (---) line represents the OLS estimates, the blue dash-dot (---·---) line represents the estimates from the multinomial treatment effects model, the green solid line (---) represents the CQR estimates with 95% confidence intervals in green dot lines (...), and the red solid line (---) represents the UQR estimates with 95% confidence intervals in gray shaded areas at various quantiles between 5th and 95th percentiles.

References
1. Bellemare, M.F.; Bloem, J.R. Does contract farming improve welfare? A review. World Dev. 2018, 112, 259–271. [CrossRef]
2. Ton, G.; Velléma, W.; Desiere, S.; Weitschat, S.; D’Haese, M. Contract farming for improving smallholder incomes: What can we learn from effectiveness studies? World Dev. 2018, 104, 46–64. [CrossRef]
3. Gramzow, A.; Batt, P.J.; Afari-Sefa, V.; Petrick, M.; Roothaert, R. Linking smallholder vegetable producers to markets—A comparison of a vegetable producer group and a contract-farming arrangement in the Lushoto District of Tanzania. J. Rural Stud. 2018, 63, 168–179. [CrossRef]
4. Nguyen, H.K.; Chiong, R.; Chica, M.; Middleton, R.H.; Pham, D.T.K. Contract farming in the Mekong Delta’s rice supply chain: Insights from an agent-based modeling study. J. Artif. Soc. Soc. Simul. 2019, 22, 1. [CrossRef]
5. Zeller, B.; Langa, L. Contract farming: Global standards or market forces? The case of the Australian dairy industry. *Unif. Law Rev.* 2018, 23, 282–297. [CrossRef]

6. Luh, Y.-H. Inclusiveness of contract farming along the modern food supply chain: Empirical evidence from Taiwan. *Agriculture* 2020, 10, 187. [CrossRef]

7. Nguyen, A.T.; Dzator, J.; Nadolny, A. Does contract farming improve productivity and income of farmers? A review of theory and evidence. *J. Dev. Areas* 2015, 49, 531–538. [CrossRef]

8. Wang, H.H.; Wang, Y.; Delgado, M.S. The transition to modern agriculture: Contract farming in developing economies. *Am. J. Agric. Econ.* 2014, 96, 1257–1271. [CrossRef]

9. Liu, Y.; Minot, N.; Wang, M. Improving market access for smallholders. In *The Sustainable Intensification of Smallholder Farming Systems*, 1st ed.; Robinson, M., Klausner, D., Eds.; Burleigh Dodds Science Publishing: London, UK, 2020; pp. 339–360.

10. Ogutu, S.O.; Ochieng, D.O.; Qaim, M. Supermarket contracts and smallholder farmers: Implications for income and multidimensional poverty. *Food Policy* 2020, 95, 101940. [CrossRef]

11. Ochieng, D.O.; Veettil, P.C.; Qaim, M. Farmers’ preferences for supermarket contracts in Kenya. *Food Policy* 2017, 68, 100–111. [CrossRef]

12. Custodio, M.C.; Demont, M.; Laborte, A.; Velasco, M. Rice Quality Defined by Urban Consumers and Value Chain Actors in South and Southeast Asia. In Proceedings of the Asian Society of Agricultural Economists 9th International Conference, Bangkok, Thailand, 11–13 January 2017.

13. Blandon, J.; Henson, S.; Cranfield, J. Small-scale farmer participation in new agri-food supply chains: Case of the supermarket supply chain for fruit and vegetables in Honduras. *J. Int. Dev.* J. Dev. Stud. Assoc. 2009, 21, 971–984. [CrossRef]

14. Otubu, K.; Nakano, Y.; Takahashi, K. Contract farming in developed and developing countries. *Annu. Rev. Resour. Econ.* 2016, 8, 353–376. [CrossRef]

15. van Landebouw, M. Structure, Land Use and Profitability of Farming in Japan. Market Report 2020 (105-0011), Department of Agriculture, Embassy of the Kindom of the Netherlands, Tokyo. Available online: https://www.agroberichtenbuitenland.nl/landeninformatie/japan/achtergrond/marktstudies/large-agricultural-corporations (accessed on 12 August 2022).

16. Reardon, T.; Timmer, C.P.; Minten, B. Supermarket revolution in Asia and emerging development strategies to include small farmers. *Proc. Natl. Acad. Sci. USA* 2012, 109, 12332–12337. [CrossRef]

17. Lin, Y.-T. Where Do You Get Your Food and Groceries? The Physical Channel Quantian Takes the Lead While Line Shopping Is the Fastest Growing. Available online: https://www.foodnext.net/column/columnist/paper/5616516067 (accessed on 12 August 2022). (In Chinese).

18. Moustier, P.; Tam, P.T.G.; Anh, D.T.; Binh, V.T.; Loc, N.T.T. The role of farmer organizations in supplying supermarkets with quality food in Vietnam. *Food Policy* 2010, 35, 69–78. [CrossRef]

19. Chang, Y.-C.; Wei, M.-F.; Luh, Y.-H. Choice of modern food distribution channels and its welfare effects: Empirical evidence from Taiwan. *Agriculture* 2021, 11, 499. [CrossRef]

20. Cariappa, A.G.; Sinha, M. Choice of paddy marketing channel and its impact: Evidence from Indian farm households. *Agric. Econ. Res. Rev.* 2020, 33, 191–204. [CrossRef]

21. Koenker, R. *Quantile Regression*; Cambridge University Press: New York, NY, USA, 2005.

22. Firpo, S.; Fortin, N.M.; Lemieux, T. Unconditional quantile regressions. *Econometrica* 2009, 77, 953–973.

23. Khanal, A.R.; Mishra, S.K.; Honey, U. Certified organic food production, financial performance, and farm size: An unconditional quantile regression approach. *Land Use Policy* 2018, 78, 367–376. [CrossRef]

24. Ma, W.; Zheng, H.; Zhu, Y.; Qi, J. Effects of cooperative membership on financial performance of banana farmers in China: A heterogeneous analysis. *Ann. Pap. Assoc. Resour. Econ.* 2022, 93, 5–27. [CrossRef]

25. Kostov, P.; Davidova, S.; Gjokaj, E. Does policy support really help farmers’ incomes: The case of Kosovo. In Proceedings of the International Association of Agricultural Economists, Virtual, 17–31 August 2021.

26. Wu, Q.; Guan, X.; Zhang, J.; Xu, Y. The role of rural infrastructure in reducing production costs and promoting resource-conserving agriculture. *Int. J. Environ. Res. Public Health* 2019, 16, 3493. [CrossRef]

27. Zheng, H.; Ma, W.; Wang, F.; Li, G. Does internet use improve technical efficiency of banana production in China? Evidence from a selectivity-corrected analysis. *Food Policy* 2021, 102, 102044. [CrossRef]

28. Rios-Avila, F. Recentered influence functions (RIFs) in Stata: RIF regression and RIF decomposition. *Stata J.* 2020, 20, 51–94. [CrossRef]

29. Luh, Y.-H.; Tsai, M.-H.; Fang, C.L. Do first-movers in the organic market stand to gain? Implications for promoting cleaner production alternatives. *J. Clean. Prod.* 2020, 262, 121156. [CrossRef]

30. Di Paolo, A. (Endogenous) occupational choices and job satisfaction among recent Spanish PhD recipients. *Int. J. Mampow.* 2016, 37, 511–535. [CrossRef]

31. Slamet, A.S.; Nakayasu, A.; Ichikawa, M. Small-scale vegetable farmers’ participation in modern retail market channels in Indonesia: The determinants of and effects on their income. *Agriculture* 2017, 7, 11. [CrossRef]

32. Miyata, S.; Minot, N.; Hu, D. Impact of contract farming on income: Linking small farmers, packers, and supermarkets in China. *World Dev.* 2009, 37, 1781–1790. [CrossRef]