Contract Farming and Food Security

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28 July 2015

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July 28, 2015

Abstract

Contract farming has often been associated with an increase in the income of participating households. It is unclear, however, whether contract farming increases other aspects of household welfare. Using data from six regions of Madagascar and a selection-on-observables design in which we control for a household's marginal utility of participating in contract farming, which we elicited via a contingent valuation experiment, we show that participating in contract farming reduces the duration of a household's hungry season by about ten days on average, and that it makes participating households about 20 percent more likely to see their hungry season end at any point in time. Further, we find that these effects are more pronounced for households with a larger number of children, and for households with a larger number of girls. This is an important result as children—especially girls—often bear the burden of food insecurity.

Keywords: Contract Farming, Outgrower Schemes, Grower-Processor Contracts, Agricultural Value Chains, Food Security

JEL Classification Codes: L24, O13, O14, Q12

*We thank Teevrat Garg for invaluable help getting the data organized. We also thank seminar participants at Cornell University's Institute for African Development as well as conference participants at the 2014 Agricultural and Applied Economics Association annual meetings, the 2014 POLICOFA conference in Dar es Salaam, and the 2015 Centre for the Study of African Economies conference at the University of Oxford for their comments and suggestions. All remaining errors are ours.

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1 Introduction

Although the benefits of economic specialization have been widely understood since the publication of Adam Smith's (1776, 1976) *Wealth of Nations*, if not earlier, a persistent lack of specialization is one of the prime factors enabling economic underdevelopment in most of the world's poorest countries. In those countries, whose economies remain largely agrarian, the structural transformation, or transition from subsistence to commercial agriculture, has so far proven elusive.

One of the first steps in the transition from subsistence to commercial agriculture—that is, the transition from many smallholder farmers producing small quantities of several crops for home consumption to fewer large farms producing large quantities of one or two crops for sale—is the emergence of an intermediate sector between the agricultural and manufacturing sectors. The institution that perhaps best represents the emergence of such an agro-industrial sector is contract farming, or the economic institution wherein a processing firm contracts the production of commercial crops out to smallholder farmers, and which constitutes the cornerstone of agricultural value chains. In one of the earliest studies of contract farming in economics, Grosh (1994) noted that the institution can resolve several market failures which result from risk and uncertainty, imperfect factor markets, and reluctance to adopt new technology. Since then, contract farming has been studied in many countries and across many crops, and the institution has often been hailed by policy makers as a tool for rural poverty alleviation.

But does participation in agricultural value chains make people better off? Although there is an important literature exploring the effects of participation in contract farming on household income or some variant thereof (Porter and Phillips-Howard, 1997; Singh, 2002; Warning and Key, 2002; Simmons, 2005; Maertens and Swinnen, 2009; Minten et al., 2009; Miyata et al., 2009; Rao and Qaim, 2011; Barrett et al., 2012; Bellemare, 2012; Michelson, 2013; Narayanan, 2014),[1] we study whether participation in contract farming improves food security, defined here as the duration of the hungry season experienced by a household, i.e., the length of time during which members of the household go without three meals a day. This question is important for three reasons. First, because the hungry season coincides with

[1] A notable exception is Dedehouanou et al. (2013), who look at the impact of contracting on the subjective well-being of farmers in Senegal.

those weeks and months before households get cash for their crops at harvest, it is not immediately obvious that the households involved in contract farming can or will save the extra income from contract farming (Dupas and Robinson, 2013); there is value in knowing whether income gains translate into other gains.[2] Second, self-control problems are more common among the poor and those who live "at the margin" (Banerjee and Mullainathan, 2010), and it is not clear whether the cash a household receives at harvest will be spent on necessities like food. Third, as a recent International Food Policy Research Institute discussion paper put it:

> Income growth alone cannot solve the problem of malnutrition ... The challenge from the nutrition perspective is how to sustainably improve the quality of diets, as well as other health-nutrition related behaviors, across different populations and age groups? (sic) In nutrition debates in developing countries there is growing interest in the capacity of the private sector to contribute to improved nutrition outcomes ... Discussions have incorporated thinking around value chain frameworks, which emerged in the late 1990s to help development actors design interventions that responded to the needs of the private sector and contributed to development outcomes. Value chain approaches can provide useful frameworks to examine the food system and the potential to achieve improved nutritional outcomes by leveraging market-based systems (Gelli et al., 2015).

Using a sample of 1,200 households and which covers more than ten contracted crops across six regions of Madagascar, we look at whether participation in contract farming appears to decrease the length of the hungry season experienced by households. Because a household's decision to participate in contract farming is likely to be jointly determined with the duration of the hungry season experienced by the same household, we use the results of a field experiment aimed at eliciting respondent willingness to pay (WTP) to participate in contract farming. We then use this WTP variable to help disentangle the potential causal relationship flowing from participation in contract farming to the duration of the hungry season from the correlation

[2]The contracts we study in this paper take place during the main agricultural season in Madagascar. Consequently, it is always the case in the data that people get paid for their contracted crops immediately after the hungry season ends.

between the two. We first use this WTP information in a regression context for a selection-on-observables design (Angrist and Pischke, 2009). We then use this WTP information to estimate average treatment effects using propensity score matching methods, since the same assumption which makes the selection-on-observables design possible also makes the conditional independence assumption likely to hold.

Our core results suggest that participation in contract farming decreases the duration of the hungry season by approximately ten days for the average household in our data. Hazards and duration model results suggest that participation in contract farming increases the likelihood that a household's hungry season will end at any given time by about 20 percent. Our propensity score matching results are largely consistent with our regression results.

In addition, our findings indicate that the beneficial effects of participation in contract farming are more pronounced (i) the greater the number of children, and (ii) the greater the number of female children in a participant household. This is important because children–especially girls–are often the ones who bear the burden of food insecurity given unequal intrahousehold allocations of food, calories, and nutrients (Barrett, 2002). Longer hungry seasons–our measure of food insecurity–can cause wasting, stunting, and a number of other health problems, and children who go hungry during their developmental process are more likely to have worse educational and health outcomes later on in life (Alderman et al., 2006; Ruel and Alderman, 2013).

The rest of this paper is organized as follows. In section 2, we discuss our empirical framework and present the details of our estimation and identification strategies. Section 3 presents the data and some descriptive statistics. In section 4, we present and discuss our empirical results. Section 5 concludes.

2 Empirical Framework

This section first presents the estimation strategy we use in order to study the impact of participation in contract farming on the duration of the hungry season—defined here as the length of time during which members of the household go without three meals a day—experienced by the households in our data. Then, because the duration of the hungry season experienced by a household is likely endogenous to its participation in contract farming, we explain the details of the identification strategy we rely on in this paper.

2.1 Estimation Strategy

2.1.1 Ordinary Least Squares and Duration Models

The core equation we estimate in this paper is

$$y_i = \alpha_1 + \underline{\beta}_1 \underline{x}_i + \gamma_1 D_i + \epsilon_i, \tag{1}$$

where $y_i \geq 0$ is the duration of the hungry season experienced by household i measured in months, $\underline{x}_i$ is a vector of control variables,[3] D_i is a variable equal to one if household i participates in contract farming and equal to zero otherwise, and ϵ_i is an error term with mean zero.

We are primarily interested in the coefficient γ which, if D were exogenous to y, would be the average treatment effect (ATE) of participating in contract farming on the duration of the hungry season, or

$$\gamma = E(y_i|D_i = 1) - E(y_i|D_i = 0). \tag{2}$$

However, D is endogenous to y because households participation in contract farming is not assigned at random. Therefore, we estimate the following version of equation 1:

$$y_i = \alpha_2 + \underline{\beta}_2 \underline{x}_i + \gamma_2 D_i + \underline{\delta}_2 \underline{w}_i + \eta_i, \tag{3}$$

where η_i is an error term with mean zero, and $\underline{w}_i$ is a vector of dummy variables that capture our respondents' answers to an experimental question aimed at eliciting WTP to participate in a hypothetical contract farming agreement. Our claim is that this WTP proxies for each respondent's marginal utility of participating in contract farming, which in turn controls for a number of unobservable characteristics which explain selection into contract farming. We thus attempt to identify the ATE of participating in contract farming on the duration of the hungry season using a selection-on-observables design, in which a coefficient is identified because the RHS variables (here, $\underline{x}$ and $\underline{w}$) account for selection into a given treatment (here, D). We further elaborate this identification strategy in section 2.2.

Because we are dealing with duration data–that is, the LHS variable measures the number of months a household's last hungry season lasted–we use three distinct estimators to estimate equation 3. The first is the ordinary least squares estimator, wherein γ tells us how much shorter the hungry

[3] Underlines are used throughout this paper to denote vectors.

season is, on average, for households that participate in contract farming. The next two estimators are the Cox proportional hazards model and the survival time regression model, two workhorse estimators used in the study of duration data (Lancaster, 1986).[4] In these two models, γ tells us how likely a household is to "exit" the condition represented by the hungry season at any given point in time. Thus, if participation in contract farming has the hypothesized beneficial effects on food security, we would expect $\gamma < 0$ in the OLS specifications (i.e., contract farming is associated with shorter hungry seasons), and $\gamma > 0$ in the Cox proportional hazards and survival time regression models (i.e., contract farming is associated with a higher likelihood of exiting the hungry season at any point in time).

2.1.2 Propensity Score Matching

Propensity score matching (PSM) is a valuable estimation strategy in the case of selection on observables (Imbens, 2015). Therefore, we use PSM as an additional estimator in this analysis. In the first stage, we estimate a probit model that is such that

$$D_i = \kappa + \underline{\lambda x}_i + \underline{\theta w}_i + \xi_i, \tag{4}$$

where the variables are labeled the same as in equation 3.

The parameters of this model are then used to estimate the propensity score for each individual. The propensity score is an estimate of each household's likelihood of participation in contract farming, given their observable characteristics and their response to the contingent valuation question.

We then match households that participate in contract farming to households that do not participate in contract farming but have a similar propensity score. In selecting a matching algorithm it is important to consider two things. The first is the number of non-participating households to match to participating households. Matching only one household raises the likelihood that the two matched households are very similar. Increasing the number of matched households can decrease the similarity between matched households but increase the pool of households upon which we draw inferences. The second important consideration is the caliper size. The caliper size determines

[4] The survival time regression requires that one make an assumption on the distribution of the survival function. We make the common assumption that the survival function follows a Weibull distribution.

how similar two households' propensity scores must be in order for the corresponding households to be matched. If the caliper size is large, it is possible to match households with very dissimilar propensity scores. If the caliper is very small, it becomes difficult to find suitable matches, and thus a large portion of observations will be dropped from the sample, and the standard errors become inflated.

To address these trade-offs we use three matching routines to match households: (i) one nearest neighbor with a caliper size of 0.01 standard deviations, (ii) three nearest neighbors with a caliper size of 0.01 standard deviations, and (iii) three nearest neighbors with a caliper size of 0.001 standard deviations. We then estimate three treatment effects: (i) the average treatment effect on the treated (ATT), (ii) the average treatment effect on the untreated (ATU), and (iii) the average treatment effect (ATE). The ATT is standard reporting for propensity score matching and tells us how treated households are affected by participation in contract farming. The ATE is the same estimator that is reported in our OLS estimates, and is thus of the most interest. This estimator tells us how the whole sample is and would be affected by participation in contract farming. One would expect the ATT to be the largest, in absolute value, followed by the ATE, and the ATU should be the smallest, in absolute value, since those who are likely to benefit the most from contract farming are more likely to select into participating.

Because the standard errors estimated in matching routines do not account for the fact that the propensity score is estimated, we use the standard error correction from Abadie and Imbens (2006), using the three nearest neighbors to calculate the conditional variance.

2.2 Identification Strategy

As discussed, we rely on a selection-on-observables identification strategy in order to estimate the impact of participation in contract farming on the duration of the hungry season. This section first explains the experimental setup that we used to elicit WTP for contract farming. It then explains how WTP for contract farming should purge the error term, η, of much of its correlation with the variables on the RHS of equation 3.

2.2.1 Experimental Setup

The contingent valuation experiment used in this paper is the same as that used in Bellemare (2012). Each respondent was asked whether he would participate in a contract farming agreement that would raise his income by 10 percent in exchange for a one-time monetary investment. The amount of the monetary investment was randomly selected from six investment amounts of \$12.50, \$25.00, \$37.50, \$50.00, \$62.50, or \$75.00.[5] The size of investment was determined at random by the throw of a regular (i.e., six-sided and fair) die. For each respondent, the data include the random dollar amount associated with the roll of the die and a "Yes" or "No" answer to whether the respondent would pay an initial investment equal to the random dollar amount in order to participate in a contract farming agreement that would increase his income by 10 percent.

The vector $\underline{w}$ in equation 3 captures respondent answers to the contingent valuation experiment. For example, a respondent who rolls a five on the die throw would be asked whether he'd like to participate in a contract farming agreement that would raise his income by 10 percent, but would require him to pay an initial investment of \$62.50. If he answered "Yes," his $\underline{w}$ vector would be equal to $(w_1, w_2, w_3, w_4, w_5, w_6) = (0, 0, 0, 0, 1, 0)$. A respondent who rolls a four on the die throw would be asked whether he'd like to participate in a contract farming agreement that would raise his income by 10 percent, but would cost \$50.00. If he answered "No," his $\underline{w}$ vector would be equal to $(0, 0, 0, 0, 0, 0)$.

The foregoing ascribes a "No" answer to all questions that a respondent was not asked. In the example above, in which the respondent is asked whether he would participate in a contract farming agreement costing \$62.50, we have coded all other amounts, \$12.50, \$25.00, \$37.50, \$50.00, and \$75.00, as "No." A clear shortcoming of that approach is that it treats the unasked questions as having been answered in the negative. To remedy that, in a second set of estimations, we impute, on the basis of observables, what each respondent's answers would be to all investment questions. So a respondent who rolls a five on the die throw and responds "Yes," meaning that he would like to participate in a contract farming agreement that would raise his income by 10 percent, but would require him to pay an initial cost of

[5] Those figures are presented in US dollars for ease of exposition. The US-dollar figures were expressed in local currency during fieldwork so respondents could more easily relate to the amounts.

\$62.50, would have a $\underline{w}$ vector equal to $(\widehat{w}_1, \widehat{w}_2, \widehat{w}_3, \widehat{w}_4, 1, \widehat{w}_6)$ where $\widehat{w}_i$ denotes an imputed value in the ith position. Because the level of investment required of each respondent (i.e., \$12.50, \$25.00, \$37.50, \$50.00, \$62.50, or \$75.00) was determined at random as part of the experiment, the level of investment is unrelated to a respondent's *observable and unobservable* characteristics, which means that the imputed responses to the unasked questions are unbiased. The shortcoming of this approach is that it relies on generated regressors. We deal with this by bootstrapping standard errors.

Lastly, in a third set of estimations, we enforce monotonic switching on the part of our respondents. That is, if a respondent answers "Yes" to participating in the hypothetical contract farming agreement for a given randomly selected investment value, we code all lower investment values as "Yes" answers as well. In doing this, we assume that someone who would be willing to pay, say, \$62.50 for a contract that would increase his income by 10 percent would also be willing to pay \$12.50, \$25.00, \$37.50, or \$50.00 for the same contract. So a respondent who rolls a five on the die throw and states that "Yes," he would like to participate in a contract farming agreement that would raise his income by 10 percent, but would require him to pay an initial cost of \$62.50, would have a $\underline{w}$ vector equal to $(1, 1, 1, 1, 1, 0)$.

In all cases, the identifying assumption we make is that a respondent's response to the contingent valuation question is correlated with his WTP to participate in contract farming, and so the vector $\underline{w}$ serves as a proxy for a respondent's marginal utility from participating in contract farming. The next section explains why this constitutes a selection-on-observables research design in the context of regression or, alternatively why it satisfies the conditional independence assumption in the context of matching.

2.2.2 Identification

How does a set of proxies for a respondent's marginal utility from participating in contract farming help identify the causal impact of participation in contract farming on the duration of the hungry season? Recall that there are three sources of statistical endogeneity:

1. Unobserved heterogeneity,
2. Reverse causality, and
3. Measurement error.

We look at each of these in turn in the remainder of this section.

Unobserved heterogeneity refers to the problem of omitted variables such as a respondent's preferences for risk and ambiguity, his entrepreneurial ability, his technical ability, and his preferences in general, all of which can compromise the identification the ATE if they happen to be correlated with both the duration of the hungry season and any of the variables on the RHS of equation 1. In this application, a great deal of this unobserved heterogeneity can be captured by differences in a respondent's marginal utility from contract farming. Take for example a respondent who is price risk averse (Bellemare et al., 2013). Such a respondent might prefer to participate in contract farming because contract farming arrangements typically insure growers against price risk. Alternatively, a respondent who is very entrepreneurial might have little to no use for contract farming given that she has her own micro-enterprise. Such a respondent might prefer not to participate in contract farming because of the opportunity cost of time associated with being in a grower-processor contract. In all such cases where a respondent's marginal utility from participating in contract farming varies because of some omitted variable, the variation in WTP measure captures the variation in respondent marginal utility, which should largely obviate concerns about unobserved heterogeneity between respondents.

Reverse causality refers to the statistical endogeneity problem that arises from the fact that the dependent variable might cause the variable of interest. In this case, households that experience a shorter hungry season may be more likely to participate in contract farming. This would compromise the identification of the ATE. This could definitely be a concern in our application given that households that have better access to food may be more willing to enter into contract farming agreements. It should be the case, however, that a respondent who is more willing to enter into a contract farming agreement will have a higher marginal utility of participating in contract farming. Our WTP measure controls for this issue much the same as it did for other changes in preferences, which should obviate concerns about reverse causality.

Finally, measurement error refers to the statistical endogeneity problem that arises from there being measurement error in whether a household participates in contract farming. This is highly unlikely to be a problem in our application given that there is no obvious advantage or disadvantage to misreporting whether one participates in contract farming or not. In addition, the sample was choice-based, i.e., the survey team aimed for a sample in which half the respondents participated in contract farming and half did

not, and the survey frame was established with village chiefs, who know who participated in contract farming and who did not. This sampling strategy thus served as a consistency check for whether people truly did participate in contract farming.

In sum, our identification strategy allows us to rule out a number of sources of bias which plague the identification of a causal effect in this context. Because we are dealing with observational data, however, it is impossible to rule out all sources of statistical endogeneity with certainty. As a result, we caution the reader against interpreting our estimate of γ as causal, although it can certainly be interpreted as suggestive of the effect of participation in contract farming on the duration of the hungry season experienced by grower households.

3 Data and Descriptive Statistics

The data used in this paper are the same as in Bellemare (2012), and this section necessarily echoes the discussion of the same data in that paper. The data were collected between July and December of 2008 for a study of contract farming commissioned by the World Bank. The data cover six regions and two communes per region. Three of these regions were chosen because they exhibited a relatively high prevalence of contract farming; the other three were chosen because the government of Madagascar viewed them as high-priority areas for economic development. In all regions, the two communes with the highest density of contract farming were surveyed. Commune-level data were obtained from the 2007 census of communes in Madagascar. Moser (2008) presents the methodology used for the commune census.

Within each of the 12 communes, two lists were generated: one a list of all households that participated in contract farming, the other a list of all households that did not. Then, 50 households were randomly selected from the list of households that participated in contract farming, and 50 were randomly selected from the list of households that did not. We use sampling weights throughout this paper to account for this choice-based sampling (Manski and Lerman, 1977), and to bring our sample as close as possible to a random sample.

The survey was conducted in rural areas of Madagascar, and thus the vast majority–96 percent–of the households in our sample derive at least

some of their income from agricultural activities. For each household, data were collected at the household, plot, crop, and contract level.

We present descriptive statistics for our sample in Table 1. The average duration of the hungry season–the length of time during which members of the household go without three meals per day, i.e., our proxy for food insecurity–for the households in our sample is 3.5 months. Approximately half of the surveyed households participate in contract farming. The average household has between five and six members, and almost half of the individuals in any given household are dependents, i.e., they are either younger than 15 or older than 65. The average household head is married and male, is 43 years old, has almost six years of education, and has over 20 years of agricultural experience. More than 20 percent of household heads are members of a farm organization other than a contract farming organization, and the average household head is forbidden from doing agriculture work for 22 days per year for religious reasons.[6]

Average household annual income is approximately US$968 with an average per capita income of US$174.[7] In Madagascar in 2008, GDP per capita was US$468, meaning households in our sample were significantly poorer than the national average. The average household owns about US$220 of agricultural equipment and tools, and about US$700 in other assets such as a house, TV, radio, and livestock. On average, households own 1.45 hectares of land.

Lastly, Table 1 displays the results of the contingent valuation experiment. As expected, the proportion of respondents who are willing to participate in contract farming declines as the investment required grows, except for an initial bump in positive responses between the $12.50 and $25 investments.

4 Empirical Results

We begin this section by presenting nonparametric evidence of the relationship between participation in contract farming and duration of the hungry

[6]The Malagasy observe a system of taboos and interdictions which dictate everything from the orientation of buildings to what a person may eat. Those taboos tend to vary at several levels, between individuals, households, villages, ethnic groups, and so on. See Ruud (1960) for a thorough treatment, and Stifel et al. (2007) for an investigation of the effects of days on which agricultural work is forbidden on agricultural productivity.

[7]USD 1 $\approx$ 2,000 Ariary at the time the data were collected.

season experienced by households. This nonparametric relationship does not account for confounding factors in the decision to participate in contract farming, it merely displays the relationship between contract farming and the duration of the hungry season. Thus, we then present parametric evidence using the selection-on-observables regression methodology discussed in Section 2 as well as propensity score matching methods. We then look at treatment heterogeneity, first by determining whether the effects of participation in contract farming on food security are more pronounced for households with more children, and second by looking at whether the effects of participation in contract farming on food security are more pronounced for households with more girls. We then discuss the results of a number of robustness checks, and conclude this section by discussing the limitations of our approach.

4.1 Nonparametric Evidence

We begin with nonparametric estimations of the relationship between contract farming and the duration of the hungry season in order to establish whether a relationship exists between participation in contract farming and food security. Kaplan-Meier (i.e., nonparametric) estimates of the survival functions for households that participate in contract farming and households that do not are displayed in Figure 1. These estimates show that contract farming participants are more likely to exit the hungry season earlier than non-participants.

Similarly, Figure 2 displays kernel density estimates of the distribution of the number of days spent in the hungry season for households that participate in contract farming and households that do not. Households that participate in contract farming experience a shorter hungry season than those that do not participate.

Both figures suggest there is a relationship between a household participating in contract farming and the length of the hungry season experienced by that same household, but neither figure can help ascertain whether that relationship is causal. In order to disentangle the potential causal relationship between contract farming and food security, we now turn to parametric evidence.

4.2 Parametric Evidence

We now estimate the relationship between participation in contract farming and duration of the hungry season using the estimation and identification strategies discussed in Section 2. We account for the endogenous choice to participate in contract farming or not by using proxy variables for respondents' marginal utility. This proxy is derived from the contingent valuation field experiment to elicited willingness to pay to participate in contract farming described above.

4.2.1 Ordinary Least Squares and Duration Models

Table 2 presents ordinary least squares (OLS), Cox proportional hazards, and survival time regression estimation results. Assuming that a month lasts 30 days on average, the OLS results suggest that participating in contract farming is associated with a nine-day decrease (-0.277 $\times$ 30) in the duration of the hungry season. Similarly, the Cox proportional hazards and survival time regression estimation results respectively suggest that a household that participates in contract farming is 17 and 19 percent more likely to exit the hungry season at any given time than a household that does not participate in contract farming. Additionally, female-headed households experience a hungry season that is about three weeks (0.73 $\times$ 30) longer than male-headed households and are 32 percent less likely to exit the hungry season at any given time, according to the Cox proportional hazards model, and 39 percent less likely, according to the survival time regression. Likewise, increases in a household head's years of education and his years of agricultural experience as well as the value of the assets owned by his household are all associated with shorter hungry seasons and a greater likelihood of exiting the hungry season at any given time. Lastly, though the contingent-valuation dummies are not individually significant in any of the models presented in Table 2, they are jointly significant at less than the 10 percent level for the OLS model.

4.2.2 Treatment Heterogeneity

We now turn to treatment heterogeneity by number of children and by number of children of each gender in the household. Table 3 shows estimation results for OLS, Cox proportional hazards, and survival time regression models in which the treatment variable (i.e., the dummy for whether a household participates in contract farming) is interacted with the number of children

in the household. Similarly, Table 4 shows estimation results for OLS, Cox proportional hazards, and survival time regression models in which the treatment variable (i.e., the dummy for whether a household participates in contract farming) is interacted with the number of children of each gender in the household.

The results in Table 3 show that participation in contract farming is associated with greater decreases in the duration of the hungry season the more children there are in the household. Specifically, for every child in the household, the duration of the hungry season decreases by about six days (-0.19 $\times$ 30) in households that participate in contract farming, and the likelihood that the household will exit the hungry season increases by 6 and 7 percent, according to the Cox proportional hazards and the survival time regression model, respectively.

Likewise, the results in Table 4 show that participation in contract farming is associated with greater decreases in the duration of the hungry season the more girls there are in the household. Specifically, for every girl in the household, the duration of the hungry season decreases by about one week (-0.22 $\times$ 30), and the likelihood that the household will exit the hungry season increases by 12 and 14 percent, according to the Cox proportional hazards and the survival time regression model, respectively.

What could account for this apparent treatment heterogeneity? In other words, why would the beneficial effects of participation in contract farming be more pronounced for households with more children, and specifically for households with more female children? Though our data do not allow determining the precise mechanism behind these findings, it is not unlikely that because children–specifically girls–require fewer calories, we may see that the addition of calories in the household creates a larger reduction in the number of skipped meals for households with more children. Additionally, it is possible that because children–especially girls–are often neglected when it comes to nutrition within the household, they are also the ones for whom any kind of welfare-increasing treatment such as participation in contract farming will have the largest positive effects. In other words, the marginal welfare impacts of participating in contract farming will be highest for children, specifically girls, and so it is not surprising that the effects of participation in contract farming on food security would be especially pronounced for households with more children and with more girls. But given that our data do not allow studying how many meals each member of the household consumes, this explanation is necessarily tentative and speculative.

Lastly, though the contingent-valuation dummies are generally not individually significant in any of the models presented in Tables 3 and 4, they are jointly significant at less than the 10 percent level in the OLS models in both Tables 3 and 4.

4.2.3 Robustness Checks

In order to determine that our results are robust, we estimated a number of alternative specifications. Table 5 presents the results of two estimators that aim at minimizing the effects of outliers. The first specification is a median regression. Intuitively, a median regression is similar to an OLS regression, except that it focuses on the conditional median rather than the conditional mean. The second specification is a robust regression (Rousseeuw and Yohai, 1987). In both cases, results are very similar to the core OLS result in the first column of table 2.

In appendix Tables A1, A2, and A3, we present estimation results similar to our core results in Table 2, 3, and 4, respectively, with one difference. In Tables A1, A2, and A3, the responses to the contingent-valuation questions that were not posed to the respondent are imputed, as detailed in section 2. Because imputations yield generated regressors, we bootstrap the standard errors but omit sampling weights in appendix Tables A1, A2, and A3. Given the results in appendix Tables A1, A2, and A3, our core results appear to be robust to a change in how we proxy for respondent marginal utility to participate in a hypothetical contract farming agreement that would increase household income by 10 percent. Similarly, when we include sampling weights but do not bootstrap the standard errors[8] in appendix Tables A4, A5, and A6, our core results appear once again robust to a change in how we proxy for respondent marginal utility to participate in a hypothetical contract farming agreement that would increase household income by 10 percent.

Appendix Table A7 presents the results of treatment regressions wherein responses to the contingent-valuation questions are used as instrumental variables for participation in contract farming, as in Bellemare (2012). Taking both the OLS results in table 2 and the treatment regression results in appendix Table A7 at face value–that is, assuming that they both identify causal impacts–would suggest that the local average treatment effect (LATE, i.e., the estimated coefficient on participation in contract farming in either column

[8] We do not show results in which we use sampling weights and bootstrapped standard errors, because the use of the latter precludes incorporating the former.

of appendix Table A7) is much larger than the average treatment effect (ATE, i.e., the estimated coefficient on participation in contract farming in the first column of Table 2). In other words, *if one is willing to believe that both specifications are well-specified and identify causal relationships*, one would conclude that participating in contract farming is associated with an almost two-month decrease in the duration of the hungry season for those households who were induced to participate because they would derive a higher marginal utility from participating in the hypothetical contract farming arrangement. But taking into account the potential effect of participating in contract farming for everyone–including nonparticipants–the effect is severely moderated. In other words, the fact that the LATE exceeds the ATE implies that compliers (i.e., those households that participate in contract farming because they derive higher marginal utility from doing so and those households that do not participate because they would not derive higher marginal utility from doing so) derive higher benefits than defiers (i.e., those households that participate but derive lower marginal utility from doing so, or households that do not participate but would derive higher marginal utility from doing so).

Finally, appendix table A8 includes the results for the model in which we enforce monotonic switching in the set of contingent valuation questions. This model yields results that are identical to those in Table 2. We thus conclude from these robustness checks that our core results are robust to alternative estimators and specifications.

4.2.4 Propensity Score Matching

Table 6 displays the results from the probit regression of participation in contract farming on household characteristics and proxy variables for marginal utility of participation in contract farming. Households with an older household head are less likely to participate in contract farming than households with a younger head. Households in which the head is a member of a farm organization are more likely to participate in contract farming than households in which the head is not a member of a farm organization. Households in which the survey respondent answered that he would be willing to pay the random dollar amount in order to participate in a hypothetical contract farming agreement are more likely to participate in contract farming than households in which the respondent answered "No."

Figure 3 displays the distribution of the propensity scores by participants and non-participants in contract farming for the full, untrimmed sample.

There is a substantial amount of overlap in the propensity scores between participants and non-participants. This overlap is crucial to estimating reliable effects of contract farming. Moreover, tables A9 to A11 present balance statistics for matched samples in all three of our matching specifications.

Table 7 displays the results of the three matching routines for the three treatment effect estimators and the unmatched sample. These results estimate (i) the effect of participation in contract farming on the length of the hungry season experienced by the household for households that participated in contract farming (ATT), (ii) what the effect of participation in contract farming would have been for households that did not participate in contract farming (ATU), and (iii) what the effect of participation in contract farming would have been for all households in the sample (ATE). As expected, the results for all three matching routines show that the largest effect is for households that did participate, followed by the effect for all households in the sample. The smallest estimated effects are for those households that did not participate. Recall that the estimated ATE is most comparable to the estimated effects for the OLS results because OLS reports the ATE.

The ATE ranges from -0.127 to -0.272. This represents a reduction in the length of the hungry season by between four and nine days. The effect for participating households is larger, i.e., the ATT ranges from -0.194 to -0.305. This is a reduction in the length of the hungry season by six to ten days–an effect that is very close to what we find using in our OLS specification in the first column of table 2.

4.3 Limitations

Despite their robustness, our results suffer from some important limitations in terms of internal validity, and in terms of the measurement of food insecurity.

In terms of internal validity, it bears iterating that our estimates of the effect of household participation in contract farming on the duration of the hungry season experienced by that household is only as good as our identification strategy. Here, in order to believe that our estimates are causal, one must trust that our proxies for respondent marginal utility of participation in contract farming derived from our contingent valuation experiment fully account for the selection process whereby households choose to participate in contract farming. This is an assumption that is untestable. Moreover, comparing the OLS specification in the first column of table 2 with a similar specification that omits the dummy variables for the contingent-valuation

question shows, via a Hausman test, that the coefficients are not statistically different between the two models, i.e., we fail to reject the null hypothesis of the Hausman test. Further, the coefficient on the contract farming dummy only goes from -0.277 in table 2 to -0.293 in a specification (not shown) that excludes the contingent valuation dummies.

This suggests one of two things: either (i) the contingent valuation questions do not do a good job of accounting for selection into contract farming, or (ii) participation in contract farming is not endogenous to the duration of the hungry season experienced by households. However unlikely the latter statement may seem, in an OLS regression (not shown) of contract farming participation on the right-hand side variables in table 2, a joint significance test of the contingent valuation dummies shows that those dummies are jointly significant at a confidence level that exceeds 99 percent. Similarly, the probit regression results in table 6 show the WTP is highly correlated with participation in contract farming. In other words, responses to the contingent valuation experiment appear to explain selection into contract farming, which would invalidate (i) above, leaving us to conclude that (ii) holds.

In terms of measurement of food insecurity, we wish to reiterate we are only measuring one aspect of food insecurity, viz. the length of time household members go without eating three meals a day. But food insecurity could be measured much more precisely by measuring each household member's consumption of calories, macronutrients (e.g., carbohydrates, fat, and protein), or micronutrients (i.e., specific vitamins and minerals). The data used in this paper were not collected for the specific purpose of studying food insecurity, and measuring food insecurity accurately would require individual- rather than household-level survey questionnaires.

5 Concluding Remarks

We have used data on 1,200 households across six regions of Madagascar to investigate the relationship between contract farming and food security by looking at whether participation in contract farming is associated with a decrease in the duration of the hungry season experienced by the households in our data.

Our results show that participation in contract farming is associated with a reduction in the duration of the hungry season by about 10 days for the average household, and that it increases the likelihood that a household will

exit the hungry season at any point in time by about 20 percent on average. These are important results because even though published research has shown that contract farming increases the income of participating farmers (Porter and Phillips-Howard, 1997; Singh, 2002; Warning and Key, 2002; Simmons, 2005; Maertens and Swinnen, 2009; Minten et al., 2009; Miyata et al., 2009; Rao and Qaim, 2011; Bellemare, 2012; Michelson, 2013; Narayanan, 2014), there has so far been no attempt to study whether contract farming leads to improvements in food security, and the link between agricultural value chains and nutrition has been deemed a high priority by policy makers (Gelli et al., 2015; FAO, 2013). Moreover, the estimated effects of participation in contract farming on the duration of the hungry season experienced by households are especially pronounced for households with more children, and for households with more female children. These are important results given that children, particularly girls, bear the largest burden of food insecurity, the consequences of which include stunting, wasting, listlessness, and cognitive impairment (Alderman et al., 2006; Ruel and Alderman, 2013).

From a behavioral perspective, our results suggest that smallholders in Madagascar save a portion of the additional income they receive from participating in contract farming in order to spend it on food in the months leading to the harvest. From a policy perspective, this suggest that policies that facilitate the development of agricultural value chains, beyond their direct welfarist effect on the incomes of those who participate as growers, can also have indirect nonwelfarist effects on those same growers' food security.

References

[1] Abadie, Alberto and Guido W. Imbens (2006), "Large Sample Properties of Matching Estimators for Average Treatment Effects," *Econometrica* 74(1): 235-267.

[2] Alderman, Harold, John Hoddinott, and Bill Kinsey (2006), "Long-Term Consequences of Early Childhood Malnutrition," *Oxford Economic Papers* 58(3): 450-474.

[3] Angrist, Joshua D., and Jörn-Steffen Pischke (2009), *Mostly Harmless Econometrics*, Princeton: Princeton University Press.

[4] Banerjee, Abhijit V., and Sendhil Mullainathan (2010), "The Shape of Temptation: Implications for the Economic Lives of the Poor," NBER Working Paper.

[5] Barrett, Christopher B. (2002), "Food Security and Food Assistance Programs," *Handbook of Agricultural Economics*, Elsevier Science B.V

[6] Barrett, Christopher B., Maren Elise Bachke, Marc F. Bellemare, Hope C. Michelson, Sudha Narayanan, and Thomas F. Walker (2012), "Smallholder Participation in Contract Farming: Comparative Evidence from Five Countries," *World Development* 40(4): 715-730.

[7] Bellemare, Marc F. (2012), "As You Sow, So Shall You Reap: The Welfare Impacts of Contract Farming," *World Development* 40(7): 1418-1434.

[8] Bellemare, Marc F., Christopher B. Barrett, and David R. Just (2013), "The Welfare Impacts of Commodity Price Volatility: Evidence from Rural Ethiopia," *American Journal of Agricultural Economics* 95(4): 877-899.

[9] Dedehouanou, Senakpon F.A., Johan Swinnen, and Miet Maertens (2013), "Does Contracting Make Farmers Happy? Evidence from Senegal," *Review of Income and Wealth* 139(S1): S138-S160.

[10] Dupas, Pascaline, and Jonathan Robinson (2013), "Savings Constraints and Microenterprise Development: Evidence from a Field Experiment in Kenya," *American Economic Journal: Applied Economics* 5(1): 163-192.

[11] FAO (2013), *The State of Food and Agriculture*, Rome: FAO.

[12] Grosh, Barbara (1994), "Contract Farming in Africa: An Application of the New Institutional Economics," *Journal of African Economies* 3(2): 231-261.

[13] Gelli, Aulo, Corinna Hawkes, Jason Donovan, Jody Harris, Summer Allen, Alan de Brauw, Spencer Henson, Nancy Johnson, James Garrett, and David Ryckembusch (2015), "Value Chains for Nutrition," Discussion Paper 01413, International Food Policy Research Institute.

[14] Imbens, Guido (2015), "Matching Methods in Practice: Three Examples, " *Journal of Human Resources* 50(2):373-419.

[15] Lancaster, Tony (1992), *The Econometric Analysis of Transition Data*, Cambridge: Cambridge University Press.

[16] Maertens, Miet, and Johan F.M. Swinnen (2009), "Trade, Standards, and Poverty: Evidence from Senegal," *World Development* 37(1): 161–178.

[17] Manski, Charles F., and Steven R. Lerman (1977), "The Estimation of Choice Probabilities from Choice Based Samples," *Econometrica* 45(8): 1977-1988.

[18] Michelson, Hope C. (2013), "Small Farmers, NGOs, and a Walmart World: Welfare Effects of Supermarkets Operating in Nicaragua," *American Journal of Agricultural Economics* 95(3): 628-649.

[19] Minten, Bart, Lalaina Randrianarison, and Johan F.M. Swinnen (2009), "Global Retail Chains and Poor Farmers: Evidence from Madagascar," *World Development* 37(11): 1728–1741.

[20] Miyata, Sachiko, Nicholas Minot, and Dinghuan Hu (2009), "Impact of Contract Farming on Income: Linking Small Farmers, Packers, and Supermarkets in China," *World Development* 37(11): 1781-1790.

[21] Naryananan, Sudha (2014), "Profits from Participation in High-Value Agriculture: Evidence of Heterogeneous Benefits in Contract Farming Schemes in Southern India," *Food Policy* 44: 142-157.

[22] Porter, Gina, and Kevin Phillips-Howard (1997), "Comparing Contracts: An Evaluation of Contract Farming Schemes in Africa," *World Development* 25(2): 227-238.

[23] Rao, Elizaphan J.O., and Matin Qaim (2011), "Supermarkets, farm household income, and poverty: Insights from Kenya," *World Development* 39(5): 784–796.

[24] Rousseuw, Peter, and Annick M. Leroy (2005), *Robust Regression and Outlier Detection*, New York: Wiley.

[25] Ruel, Marie T., and Harold Alderman (2013), "Nutrition-Sensitive Interventions and Programmes: How Can They Help to Accelerate Progress in Improving Maternal and Child Nutrition?," *The Lancet* 382(9891): 536-551.

[26] Ruud, Jørgen (1960), *Taboo: A Study of Malagasy Customs and Beliefs*, Oslo: Oslo University Press.

[27] Simmons, Phil, Paul Winters, and Ian Patrick (2005), "An Analysis of Contract Farming in East Java, Bali, and Lombok, Indonesia," *Agricultural Economics* 33(s3): 513–525.

[28] Singh, Sukhpal (2002), "Contracting Out Solutions: Political Economy of Contract Farming in the Indian Punjab," *World Development* 30(9): 1621–1638.

[29] Smith, Adam (1976 [1776]), *An Inquiry into the Nature and Causes of the Wealth of Nations*, Chicago: University of Chicago Press.

[30] Stephens, Emma C., and Christopher B. Barrett (2011), "Incomplete Credit Markets and Commodity Marketing Behavior," *Journal of Agricultural Economics* 62(1): 1-24.

[31] Stifel, David, Marcel Fafchamps, and Bart Minten (2007), "Taboos, Agriculture, and Poverty," *Journal of Development Studies* 47(10): 1455-1481.

[32] Warning, Matthew, and Nigel Key (2002), "The Social Performance and Distributional Consequences of Contract Farming: An Equilibrium Analysis of the Arachide de bouche Program in Senegal," *World Development* 30(2): 255–263.

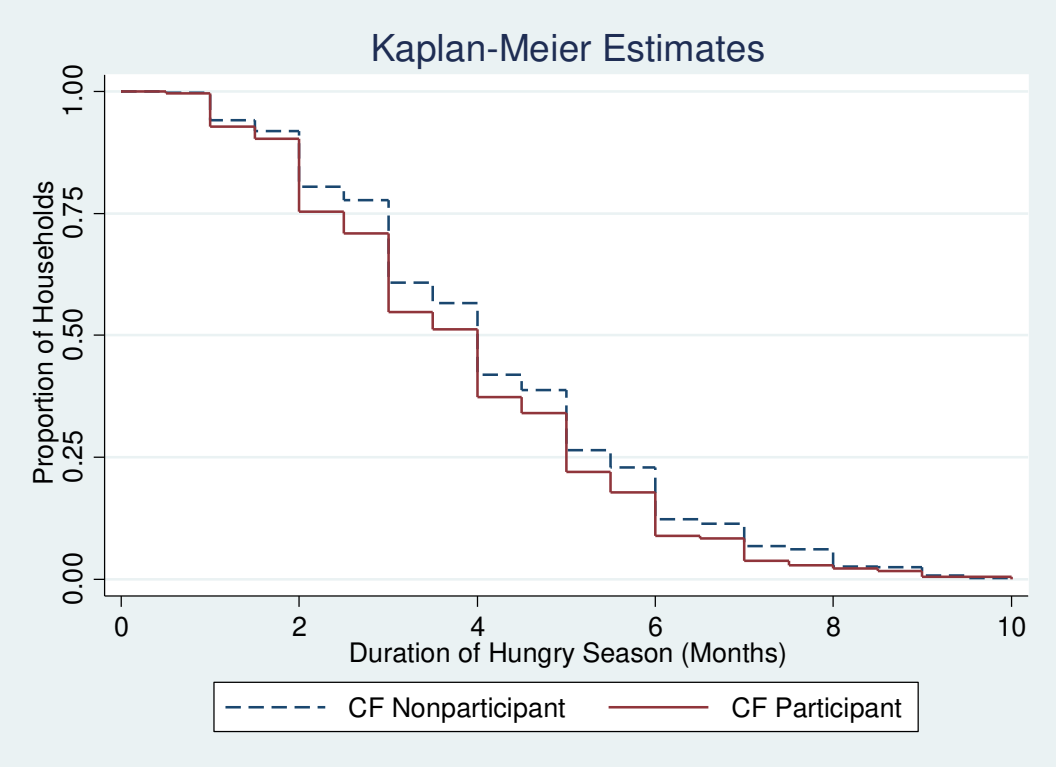

Figure 1. Kaplan-Meier Estimates of the Effect of Participation in Contract Farming (CF) on the Duration of the Hungry Season.

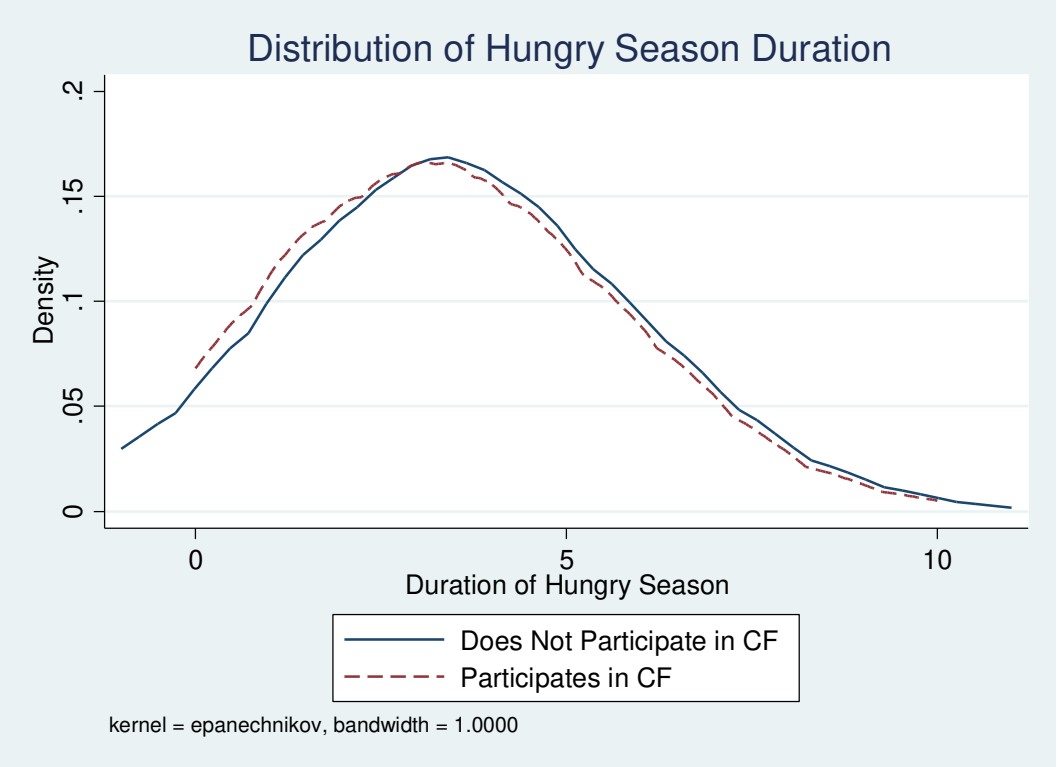

Figure 2. Kernel Density Estimates of the Duration of the Hungry Season by Contract Farming Participation Status.

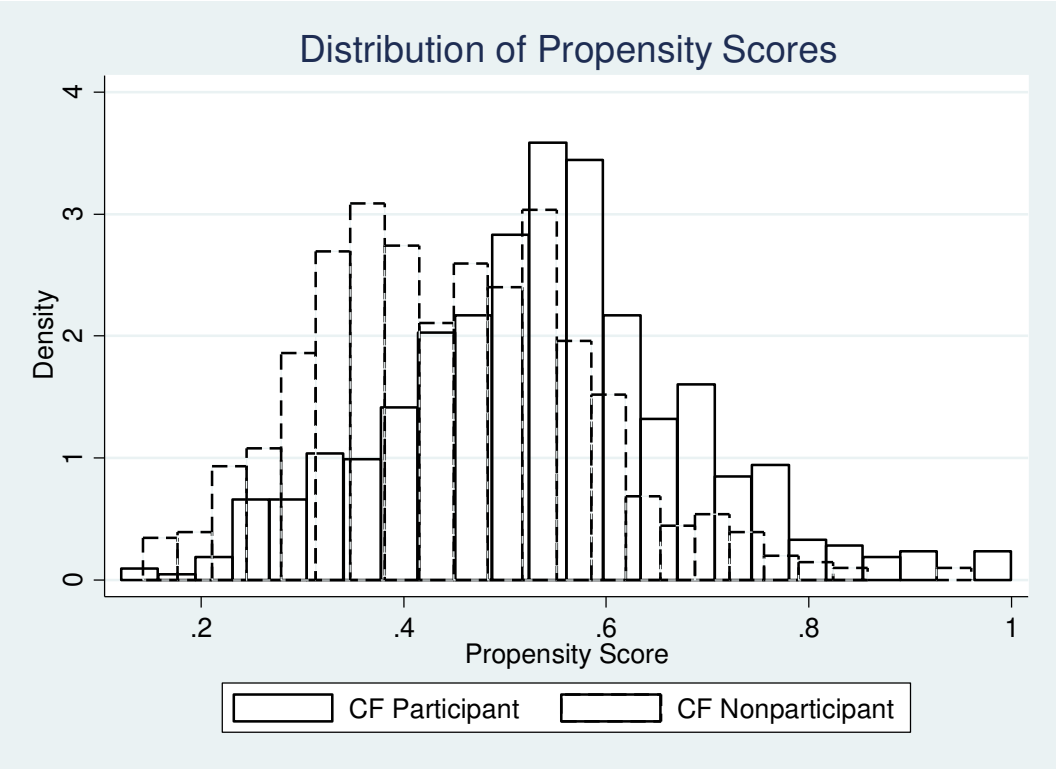

Figure 3. Distribution of Propensity Scores by Participation Regime. Solid Lines Denote Participants in Contract Farming; Dashed Lines Denote Nonparticipants.

Table 1. Descriptive Statistics

Variables	Mean (Std. Err.)
Duration of Hungry Season (Months)	3.507
	(0.076)
Contract Farming Participant (Dummy)	0.498
	(0.016)
Household Size (Individuals)	5.571
	(0.075)
Dependency Ratio	0.449
	(0.008)
Household Head Single (Dummy)	0.124
	(0.011)
Household Head Female (Dummy)	0.088
	(0.010)
Household Head Migrant (Dummy)	0.125
	(0.011)
Household Head Age (Years)	43.274
	(0.431)
Household Head Education (Years)	5.682
	(0.106)
Household Head Agricultural Experience (Years)	20.621
	(0.433)
Household Head Member of Farm Organization	0.222
	(0.014)
Days Agricultural Work Forbidden (Days/Year)	22.204
	(1.105)
Household Income (100,000 Ariary)	19.531
	(1.506)
Household Working Capital (100,000 Ariary)	4.440
	(0.522)
Household Assets (100,000 Ariary)	13.965
	(0.876)
Household Landholdings (100 Square Meters)	145.569
	(10.138)
"Yes" to $12.50 Investment	0.132
	(0.011)
"Yes" to $25.00 Investment	0.179
	(0.013)
"Yes" to $37.50 Investment	0.157
	(0.012)
"Yes" to $50.00 Investment	0.133
	(0.011)

"Yes" to $62.50 Investment	0.069
	(0.009)
"Yes" to $75.00 Investment	0.066
	(0.008)
Observations	1,178

Robust standard errors in parentheses

Table 2. Estimation Results for OLS, Cox Proportional Hazard, and Survival-Time Regressions.

Variables	OLS	Cox	Survival Time
Dependent Variable: Duration of Hungry Season			
Contract Farming Participant	-0.277*	0.166***	0.188***
	(0.145)	(0.063)	(0.071)
Household Size	0.052	-0.013	-0.015
	(0.036)	(0.015)	(0.017)
Dependency Ratio	0.517	-0.226	-0.247
	(0.366)	(0.158)	(0.181)
Household Head Single	-0.126	0.042	0.068
	(0.343)	(0.147)	(0.167)
Household Head Female	0.732*	-0.323*	-0.390*
	(0.402)	(0.175)	(0.202)
Household Head Migrant	0.064	0.014	0.009
	(0.219)	(0.101)	(0.115)
Household Head Age	0.021**	-0.003	-0.003
	(0.009)	(0.004)	(0.005)
Household Head Education	-0.068***	0.022**	0.026**
	(0.022)	(0.010)	(0.011)
Household Head Agricultural Experience	-0.029***	0.005	0.004
	(0.010)	(0.004)	(0.005)
Household Head Member of Farm Organization	0.091	-0.095	-0.125
	(0.183)	(0.088)	(0.100)
Days Agricultural Work Forbidden	-0.003	0.000	0.000
	(0.002)	(0.001)	(0.001)
Household Income	-0.004**	0.000	0.000
	(0.002)	(0.001)	(0.002)
Household Working Capital	0.002	0.006***	0.007***
	(0.003)	(0.002)	(0.002)
Household Assets	-0.013***	0.004***	0.005***
	(0.003)	(0.001)	(0.002)
Household Landholdings	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
"Yes" to $12.50 Investment	0.218	-0.033	-0.027
	(0.217)	(0.095)	(0.107)
"Yes" to $25.00 Investment	-0.396*	0.106	0.127
	(0.226)	(0.091)	(0.104)
"Yes" to $37.50 Investment	-0.388*	0.126	0.147
	(0.211)	(0.097)	(0.111)
"Yes" to $50.00 Investment	-0.205	-0.018	-0.017
	(0.243)	(0.112)	(0.128)
"Yes" to $62.50 Investment	-0.142	0.004	0.006
	(0.299)	(0.136)	(0.158)

"Yes" to $75.00 Investment	0.151	-0.226	-0.234
	(0.342)	(0.169)	(0.186)
Constant	3.793***	-	-4.152***
	(0.456)		(0.256)
Observations	1,178	1,045	1,045
District Dummies	Yes	Yes	Yes
R-squared	0.206	-	-

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3. Estimation Results for OLS, Cox Proportional Hazard, and Survival-Time Regressions Exploring Treatment Heterogeneity I.

Variables	OLS	Cox	Survival Time
Dependent Variable: Duration of Hungry Season			
Contract Farming Participant	0.210	0.009	0.004
	(0.253)	(0.109)	(0.125)
Contract Farming Participant x Number of Kids	-0.191**	0.060*	0.070*
	(0.082)	(0.034)	(0.039)
Number of Kids in Household	0.172	-0.053	-0.060
	(0.121)	(0.050)	(0.057)
Household Size	0.007	0.002	0.002
	(0.059)	(0.028)	(0.032)
Dependency Ratio	0.255	-0.168	-0.187
	(0.583)	(0.231)	(0.259)
Household Head Single	-0.164	0.056	0.085
	(0.349)	(0.150)	(0.171)
Household Head Female	0.765*	-0.330*	-0.399*
	(0.406)	(0.176)	(0.204)
Household Head Migrant	0.066	0.006	-0.002
	(0.219)	(0.102)	(0.115)
Household Head Age	0.024**	-0.004	-0.004
	(0.010)	(0.004)	(0.005)
Household Head Education	-0.068***	0.022**	0.026**
	(0.022)	(0.010)	(0.012)
Household Head Agricultural Experience	-0.029***	0.004	0.003
	(0.010)	(0.004)	(0.005)
Household Head Member of Farm Organization	0.087	-0.088	-0.115
	(0.180)	(0.086)	(0.097)
Days Agricultural Work Forbidden	-0.003	0.000	0.001
	(0.002)	(0.001)	(0.001)
Household Income	-0.004**	0.000	0.000
	(0.002)	(0.001)	(0.002)
Household Working Capital	0.002	0.005***	0.007***
	(0.003)	(0.002)	(0.002)
Household Assets	-0.013***	0.004***	0.005***
	(0.003)	(0.001)	(0.001)
Household Landholdings	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
"Yes" to $12.50 Investment	0.197	-0.028	-0.022
	(0.217)	(0.095)	(0.107)
"Yes" to $25.00 Investment	-0.415*	0.107	0.126
	(0.227)	(0.091)	(0.104)
"Yes" to $37.50 Investment	-0.372*	0.124	0.144

	(0.211)	(0.098)	(0.112)
"Yes" to $50.00 Investment	-0.196	-0.004	0.000
	(0.238)	(0.108)	(0.124)
"Yes" to $62.50 Investment	-0.142	0.011	0.014
	(0.291)	(0.136)	(0.157)
"Yes" to $75.00 Investment	0.194	-0.245	-0.258
	(0.341)	(0.171)	(0.188)
Constant	3.592***	-	-4.078***
	(0.487)		(0.271)
Observations	1,178	1,045	1,045
District Fixed Effects	Yes	Yes	Yes
R-squared	0.213	-	-

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4. Estimation Results for OLS, Cox Proportional Hazard, and Survival-Time Regressions Exploring Treatment Heterogeneity II.

Variables	OLS	Cox	Survival Time
Dependent Variable: Duration of Hungry Season			
Contract Farming Participant	0.206	-0.005	-0.013
	(0.254)	(0.109)	(0.125)
Contract Farming Participant x Girls	-0.215*	0.118**	0.137**
	(0.120)	(0.054)	(0.061)
Contract Farming Participant x Boys	-0.163	0.015	0.018
	(0.120)	(0.048)	(0.054)
Number of Girls in the Household	0.214	-0.067	-0.076
	(0.133)	(0.056)	(0.063)
Number of Boys in the Household	0.129	-0.026	-0.028
	(0.141)	(0.057)	(0.065)
Household Size	0.007	-0.002	-0.003
	(0.059)	(0.028)	(0.032)
Dependency Ratio	0.258	-0.196	-0.223
	(0.584)	(0.231)	(0.258)
Household Head Single	-0.167	0.058	0.088
	(0.348)	(0.148)	(0.169)
Household Head Female	0.766*	-0.336*	-0.406**
	(0.406)	(0.175)	(0.202)
Household Head Migrant	0.061	-0.001	-0.009
	(0.221)	(0.102)	(0.116)
Household Head Age	0.024**	-0.004	-0.004
	(0.010)	(0.004)	(0.005)
Household Head Education	-0.067***	0.023**	0.027**
	(0.023)	(0.010)	(0.012)
Household Head Agricultural Experience	-0.029***	0.004	0.003
	(0.010)	(0.004)	(0.005)
Household Head Member of Farm Organization	0.084	-0.096	-0.123
	(0.179)	(0.086)	(0.098)
Days Agricultural Work Forbidden	-0.003	0.000	0.001
	(0.002)	(0.001)	(0.001)
Household Income	-0.004**	0.001	0.001
	(0.002)	(0.001)	(0.002)
Household Working Capital	0.002	0.005***	0.006***
	(0.003)	(0.002)	(0.002)
Household Assets	-0.013***	0.004***	0.005***
	(0.003)	(0.001)	(0.001)
Household Landholdings	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
"Yes" to $12.50 Investment	0.191	-0.025	-0.017

	(0.216)	(0.095)	(0.106)
"Yes" to $25.00 Investment	-0.420*	0.104	0.122
	(0.226)	(0.091)	(0.104)
"Yes" to $37.50 Investment	-0.366*	0.122	0.143
	(0.212)	(0.098)	(0.111)
"Yes" to $50.00 Investment	-0.193	-0.015	-0.012
	(0.238)	(0.108)	(0.125)
"Yes" to $62.50 Investment	-0.138	-0.003	-0.003
	(0.290)	(0.137)	(0.159)
"Yes" to $75.00 Investment	0.193	-0.250	-0.265
	(0.342)	(0.171)	(0.189)
Constant	3.586***	-	-4.069***
	(0.486)		(0.271)
Observations	1,178	1,045	1,045
District Fixed Effects	Yes	Yes	Yes
R-squared	0.213	-	-

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5. Estimation Results for Median and Robust Regressions.

Variables	(1) Median	(2) Robust
Dependent Variable: Duration of Hungry Season		
Contract Farming Participant	-0.306**	-0.255**
	(0.147)	(0.121)
Household Size	0.023	0.040
	(0.035)	(0.029)
Dependency Ratio	0.331	0.364
	(0.354)	(0.291)
Household Head Single	0.275	0.114
	(0.347)	(0.285)
Household Head Female	0.095	0.290
	(0.396)	(0.326)
Household Head Migrant	-0.034	0.070
	(0.227)	(0.187)
Household Head Age	0.022**	0.024***
	(0.011)	(0.009)
Household Head Education	-0.040*	-0.049**
	(0.023)	(0.019)
Household Head Agricultural Experience	-0.022**	-0.026***
	(0.011)	(0.009)
Household Head Member of Farm Organization	-0.092	-0.037
	(0.180)	(0.148)
Agricultural Work Forbidden	-0.002	-0.003
	(0.003)	(0.002)
Household Income	-0.008***	-0.006***
	(0.002)	(0.002)
Household Working Capital	0.002	0.002
	(0.004)	(0.003)
Household Assets	-0.011***	-0.012***
	(0.003)	(0.002)
Household Landholdings	0.000	-0.000
	(0.000)	(0.000)
"Yes" to $12.50 Investment	0.217	0.191
	(0.246)	(0.202)
"Yes" to $25.00 Investment	-0.489**	-0.419**
	(0.229)	(0.188)
"Yes" to $37.50 Investment	-0.248	-0.269
	(0.231)	(0.190)
"Yes" to $50.00 Investment	-0.480**	-0.356*
	(0.242)	(0.199)
"Yes" to $62.50 Investment	-0.158	-0.185

	(0.313)	(0.257)
"Yes" to $75.00 Investment	-0.285	-0.191
	(0.298)	(0.245)
Constant	3.999***	3.751***
	(0.472)	(0.388)
Observations	1,178	1,178
District Fixed Effects	Yes	Yes
R-squared	-	0.200

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 6. Probit Regression Results for Propensity Score Estimation

Variables	Probit
Dependent Variable: Contract Farming Participant	
Household Size	0.013
	(0.019)
Dependency Ratio	-0.019
	(0.191)
Household Head is Single	-0.162
	(0.188)
Household Head is Female	-0.189
	(0.217)
Household Head is Migrant	0.040
	(0.123)
Household Head Age	-0.014**
	(0.006)
Household Head Education	-0.015
	(0.013)
Household Head Agricultural Experience	0.008
	(0.006)
Household Head Member of Farm Organization	0.472***
	(0.097)
Days Agricultural Work is Forbidden	-0.002
	(0.001)
Household Income	0.002
	(0.002)
Household Working Capital	0.004
	(0.004)
Household Assets	0.001
	(0.002)
Household Landholdings	0.000*
	(0.000)
Yes to $12.50 Investment	0.299**
	(0.131)
Yes to $25.00 Investment	0.433***
	(0.122)
Yes to $37.50 Investment	0.434***
	(0.123)
Yes to $50.00 Investment	0.596***
	(0.129)
Yes to $62.50 Investment	0.372**
	(0.167)
Yes to $75.00 Investment	0.569***

	(0.158)
Constant	0.131
	(0.247)
Observations	1,178
District Dummies	Yes
Pseudo R-squared	0.069
Log Likelihood	-760.359

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 7. Outcome Variable: Duration of Hungry Season

Sample	1 Neighbor Caliper 0.01	3 Neighbors Caliper 0.01	3 Neighbors Caliper 0.001
Unmatched Sample	-0.400***	-0.400***	-0.400***
	(0.123)	(0.123)	(0.123)
Average Treatment Effect on the Treated	-0.194	-0.305	-0.295
	(0.234)	(0.223)	(0.255)
Average Treatment Effect on the Untreated	-0.062	-0.204	-0.249
	(0.225)	(0.207)	(0.269)
Average Treatment Effect	-0.127	-0.252	-0.272
	(0.204)	(0.196)	(0.241)

Standard errors in parentheses. Standard errors calculated using three neighbors to calculate conditional variance as in Abadie and Imbens (2006). *** p<0.01, ** p<0.05, * p<0.1

Appendix

Table A1. Estimation Results for OLS, Cox Proportional Hazard, and Survival-Time Regressions. Missing Contingent Valuation Responses Imputed; No Sampling Weights, Bootstrapped Standard Errors.

Variables	OLS	Cox	Survival Time
Dependent Variable: Duration of Hungry Season			
Contract Farming Participant	-0.296**	0.118**	0.133*
	(0.124)	(0.060)	(0.070)
Household Size	0.048	-0.017	-0.020
	(0.033)	(0.017)	(0.020)
Dependency Ratio	0.270	0.048	0.071
	(0.346)	(0.176)	(0.211)
Household Head Single	-0.029	-0.029	-0.010
	(0.302)	(0.140)	(0.169)
Household Head Female	0.348	-0.140	-0.180
	(0.347)	(0.176)	(0.217)
Household Head Migrant	0.201	-0.033	-0.050
	(0.217)	(0.116)	(0.138)
Household Head Age	0.008	-0.003	-0.003
	(0.013)	(0.006)	(0.008)
Household Head Education	-0.057***	0.013	0.015
	(0.021)	(0.011)	(0.013)
Household Head Agricultural Experience	-0.014	0.002	0.001
	(0.013)	(0.006)	(0.007)
Household Head Member of Farm Organization	0.055	-0.113	-0.153
	(0.160)	(0.089)	(0.105)
Agricultural Work Forbidden	0.001	-0.000	-0.000
	(0.003)	(0.001)	(0.002)
Household Income	-0.005*	0.002	0.002
	(0.003)	(0.001)	(0.002)
Household Working Capital	-0.003	0.007**	0.008**
	(0.005)	(0.003)	(0.004)
Household Assets	-0.013***	0.004**	0.005**
	(0.003)	(0.002)	(0.002)
Household Landholdings	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
"Yes" to $12.50 Investment (Imputed)	-0.347	0.100	0.090
	(0.302)	(0.158)	(0.191)
"Yes" to $25.00 Investment (Imputed)	-0.206	0.047	0.044
	(0.344)	(0.172)	(0.199)
"Yes" to $37.50 Investment (Imputed)	-0.206	-0.070	-0.106
	(0.300)	(0.136)	(0.165)
"Yes" to $50.00 Investment (Imputed)	0.140	0.191	0.230

	(0.351)	(0.196)	(0.229)
"Yes" to $62.50 Investment (Imputed)	-0.734	0.265	0.327
	(0.500)	(0.240)	(0.279)
"Yes" to $75.00 Investment (Imputed)	-0.117	-0.119	-0.138
	(0.322)	(0.170)	(0.199)
Constant	5.281***	-	-4.328***
	(1.041)		(0.627)
Observations	1,178	1,045	1,045
District Fixed Effects	Yes	Yes	Yes
R-squared	0.196	-	-

Bootstrapped standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A2. Estimation Results for OLS, Cox Proportional Hazard, and Survival-Time Regressions Exploring Treatment Heterogeneity I. Missing Contingent Valuation Responses Imputed; No Sampling Weights, Bootstrapped Standard Errors.

Variables	OLS	Cox	Survival Time
Dependent Variable: Duration of Hungry Season			
Contract Farming Participant	0.044	-0.050	-0.064
	(0.219)	(0.104)	(0.126)
Contract Farming Participant x Number of Kids	-0.132*	0.064*	0.075*
	(0.070)	(0.034)	(0.041)
Number of Kids in Household	0.127	-0.096**	-0.118**
	(0.102)	(0.047)	(0.055)
Household Size	0.015	0.019	0.027
	(0.056)	(0.029)	(0.034)
Dependency Ratio	0.026	0.277	0.356
	(0.506)	(0.235)	(0.276)
Household Head Single	-0.034	-0.017	0.008
	(0.307)	(0.139)	(0.169)
Household Head Female	0.349	-0.129	-0.167
	(0.349)	(0.175)	(0.216)
Household Head Migrant	0.191	-0.037	-0.055
	(0.218)	(0.116)	(0.138)
Household Head Age	0.010	-0.004	-0.003
	(0.013)	(0.006)	(0.008)
Household Head Education	-0.057***	0.014	0.016
	(0.021)	(0.011)	(0.013)
Household Head Agricultural Experience	-0.014	0.001	-0.001
	(0.013)	(0.006)	(0.007)
Household Head Member of Farm Organization	0.047	-0.104	-0.139
	(0.160)	(0.088)	(0.104)
Agricultural Work Forbidden	0.001	-0.000	-0.001
	(0.003)	(0.001)	(0.002)
Household Income	-0.005*	0.002	0.002
	(0.003)	(0.001)	(0.002)
Household Working Capital	-0.003	0.006**	0.008**
	(0.005)	(0.003)	(0.004)
Household Assets	-0.013***	0.004**	0.005**
	(0.003)	(0.002)	(0.002)
Household Landholdings	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
"Yes" to $12.50 Investment (Imputed)	-0.385	0.128	0.126
	(0.306)	(0.161)	(0.195)
"Yes" to $25.00 Investment (Imputed)	-0.242	0.066	0.063
	(0.343)	(0.174)	(0.201)

"Yes" to $37.50 Investment (Imputed)	-0.194	-0.075	-0.111
	(0.304)	(0.138)	(0.166)
"Yes" to $50.00 Investment (Imputed)	0.142	0.205	0.250
	(0.347)	(0.193)	(0.225)
"Yes" to $62.50 Investment (Imputed)	-0.725	0.288	0.360
	(0.496)	(0.241)	(0.281)
"Yes" to $75.00 Investment (Imputed)	-0.086	-0.162	-0.194
	(0.318)	(0.169)	(0.198)
Constant	5.188***	-	-4.410***
	(1.040)		(0.633)
Observations	1,178	1,045	1,045
District Fixed Effects	Yes	Yes	Yes
R-squared	0.199	-	-

Bootstrapped standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A3. Estimation Results for OLS, Cox Proportional Hazard, and Survival-Time Regressions Exploring Treatment Heterogeneity II. Missing Contingent Valuation Responses Imputed; No Sampling Weights, Bootstrapped Standard Errors.

Variables	OLS	Cox	Survival Time
Dependent Variable: Duration of Hungry Season			
Contract Farming Participant	0.048	-0.060	-0.074
	(0.218)	(0.107)	(0.129)
Contract Farming Participant x Girls	-0.167*	0.096*	0.106
	(0.101)	(0.058)	(0.069)
Contract Farming Participant x Boys	-0.101	0.043	0.054
	(0.100)	(0.049)	(0.058)
Number of Girls in the Household	0.136	-0.091*	-0.112*
	(0.115)	(0.054)	(0.062)
Number of Boys in the Household	0.112	-0.092*	-0.114*
	(0.115)	(0.055)	(0.064)
Household Size	0.017	0.015	0.023
	(0.056)	(0.029)	(0.034)
Dependency Ratio	0.036	0.256	0.333
	(0.505)	(0.238)	(0.280)
Household Head Single	-0.034	-0.019	0.006
	(0.308)	(0.141)	(0.171)
Household Head Female	0.348	-0.126	-0.164
	(0.350)	(0.177)	(0.219)
Household Head Migrant	0.193	-0.035	-0.052
	(0.218)	(0.117)	(0.138)
Household Head Age	0.010	-0.004	-0.003
	(0.013)	(0.006)	(0.008)
Household Head Education	-0.057***	0.014	0.017
	(0.021)	(0.011)	(0.013)
Household Head Agricultural Experience	-0.014	0.001	-0.000
	(0.013)	(0.006)	(0.007)
Household Head Member of Farm Organization	0.045	-0.109	-0.145
	(0.160)	(0.088)	(0.104)
Agricultural Work Forbidden	0.001	-0.000	-0.001
	(0.003)	(0.001)	(0.002)
Household Income	-0.005*	0.002	0.002
	(0.003)	(0.001)	(0.002)
Household Working Capital	-0.003	0.006**	0.007**
	(0.005)	(0.003)	(0.004)
Household Assets	-0.013***	0.004**	0.005**
	(0.003)	(0.002)	(0.002)
Household Landholdings	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)

"Yes" to $12.50 Investment (Imputed)	-0.386	0.133	0.133
	(0.307)	(0.159)	(0.192)
"Yes" to $25.00 Investment (Imputed)	-0.246	0.067	0.064
	(0.344)	(0.175)	(0.203)
"Yes" to $37.50 Investment (Imputed)	-0.196	-0.069	-0.104
	(0.304)	(0.141)	(0.171)
"Yes" to $50.00 Investment (Imputed)	0.144	0.209	0.255
	(0.345)	(0.194)	(0.226)
"Yes" to $62.50 Investment (Imputed)	-0.720	0.266	0.337
	(0.494)	(0.241)	(0.281)
"Yes" to $75.00 Investment (Imputed)	-0.085	-0.166	-0.198
	(0.319)	(0.170)	(0.200)
Constant	5.183***	-	-4.396***
	(1.041)		(0.636)
Observations	1,178	1,045	1,045
District Fixed Effects	Yes	Yes	Yes
R-squared	0.199	-	-

Bootstrapped standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A4. Estimation Results for OLS, Cox Proportional Hazard, and Survival-Time Regressions. Missing Contingent Valuation Responses Imputed; with Sampling Weights.

Variables	OLS	Cox	Survival Time
Dependent Variable: Duration of Hungry Season			
Contract Farming Participant	-0.275*	0.151**	0.171**
	(0.145)	(0.063)	(0.071)
Household Size	0.046	-0.005	-0.006
	(0.039)	(0.018)	(0.020)
Dependency Ratio	0.498	-0.242	-0.268
	(0.428)	(0.193)	(0.222)
Household Head Single	-0.224	0.034	0.065
	(0.343)	(0.151)	(0.173)
Household Head Female	0.799*	-0.263	-0.331
	(0.412)	(0.188)	(0.220)
Household Head Migrant	0.134	0.058	0.051
	(0.254)	(0.120)	(0.137)
Household Head Age	-0.003	0.004	0.005
	(0.014)	(0.006)	(0.007)
Household Head Education	-0.077***	0.021**	0.025**
	(0.024)	(0.011)	(0.012)
Household Head Agricultural Experience	-0.008	-0.003	-0.005
	(0.014)	(0.006)	(0.007)
Household Head Member of Farm Organization	0.049	-0.118	-0.157
	(0.191)	(0.094)	(0.108)
Agricultural Work Forbidden	0.002	-0.001	-0.001
	(0.003)	(0.001)	(0.001)
Household Income	-0.003	0.000	0.000
	(0.002)	(0.001)	(0.002)
Household Working Capital	-0.008	0.009***	0.011***
	(0.006)	(0.002)	(0.003)
Household Assets	-0.017***	0.005***	0.006***
	(0.004)	(0.002)	(0.002)
Household Landholdings	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
"Yes" to $12.50 Investment (Imputed)	-0.369	0.094	0.103
	(0.398)	(0.173)	(0.197)
"Yes" to $25.00 Investment (Imputed)	-0.341	0.048	0.041
	(0.419)	(0.187)	(0.209)
"Yes" to $37.50 Investment (Imputed)	-0.349	-0.016	-0.012
	(0.322)	(0.156)	(0.183)
"Yes" to $50.00 Investment (Imputed)	0.546	-0.076	-0.079
	(0.405)	(0.186)	(0.212)
"Yes" to $62.50 Investment (Imputed)	-1.171**	0.385*	0.440*

	(0.505)	(0.214)	(0.239)
"Yes" to $75.00 Investment (Imputed)	0.021	-0.253	-0.267
	(0.416)	(0.192)	(0.217)
Constant	5.876***	-	-4.528***
	(1.150)		(0.596)
Observations	1,178	1,045	1,045
District Fixed Effects	Yes	Yes	Yes
R-squared	0.205	-	-

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A5. Estimation Results for OLS, Cox Proportional Hazard, and Survival-Time Regressions Exploring Treatment Heterogeneity I. Missing Contingent Valuation Responses Imputed; with Sampling Weights.

Variables	OLS	Cox	Survival Time
Dependent Variable: Duration of Hungry Season			
Contract Farming Participant	0.217	-0.010	-0.020
	(0.254)	(0.109)	(0.125)
Contract Farming Participant x Number of Kids	-0.193**	0.061*	0.073*
	(0.081)	(0.035)	(0.039)
Number of Kids in Household	0.172	-0.066	-0.077
	(0.117)	(0.049)	(0.056)
Household Size	0.003	0.016	0.019
	(0.062)	(0.029)	(0.033)
Dependency Ratio	0.220	-0.124	-0.133
	(0.602)	(0.255)	(0.288)
Household Head Single	-0.248	0.041	0.074
	(0.349)	(0.154)	(0.176)
Household Head Female	0.809*	-0.251	-0.315
	(0.414)	(0.190)	(0.222)
Household Head Migrant	0.121	0.054	0.044
	(0.255)	(0.122)	(0.138)
Household Head Age	0.000	0.003	0.004
	(0.014)	(0.006)	(0.007)
Household Head Education	-0.076***	0.021*	0.025**
	(0.024)	(0.011)	(0.012)
Household Head Agricultural Experience	-0.009	-0.004	-0.006
	(0.014)	(0.006)	(0.007)
Household Head Member of Farm Organization	0.043	-0.110	-0.146
	(0.189)	(0.092)	(0.106)
Agricultural Work Forbidden	0.002	-0.001	-0.001
	(0.003)	(0.001)	(0.001)
Household Income	-0.003	0.000	0.000
	(0.002)	(0.001)	(0.002)
Household Working Capital	-0.008	0.008***	0.010***
	(0.006)	(0.003)	(0.003)
Household Assets	-0.016***	0.005***	0.006***
	(0.004)	(0.002)	(0.002)
Household Landholdings	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
"Yes" to $12.50 Investment (Imputed)	-0.420	0.126	0.144
	(0.409)	(0.179)	(0.203)
"Yes" to $25.00 Investment (Imputed)	-0.400	0.069	0.063
	(0.417)	(0.187)	(0.208)

"Yes" to $37.50 Investment (Imputed)	-0.297	-0.033	-0.032
	(0.325)	(0.159)	(0.187)
"Yes" to $50.00 Investment (Imputed)	0.540	-0.059	-0.058
	(0.399)	(0.181)	(0.205)
"Yes" to $62.50 Investment (Imputed)	-1.150**	0.402*	0.463*
	(0.499)	(0.216)	(0.242)
"Yes" to $75.00 Investment (Imputed)	0.086	-0.293	-0.317
	(0.407)	(0.193)	(0.219)
Constant	5.628***	-	-4.517***
	(1.146)		(0.606)
Observations	1,178	1,045	1,045
District Fixed Effects	Yes	Yes	Yes
R-squared	0.211	-	-

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A6. Estimation Results for OLS, Cox Proportional Hazard, and Survival-Time Regressions Exploring Treatment Heterogeneity II. Missing Contingent Valuation Responses Imputed; with Sampling Weights.

Variables	OLS	Cox	Survival Time
Dependent Variable: Duration of Hungry Season			
Contract Farming Participant	0.214	-0.023	-0.035
	(0.255)	(0.109)	(0.125)
Contract Farming Participant x Girls	-0.223*	0.115**	0.133**
	(0.119)	(0.056)	(0.063)
Contract Farming Participant x Boys	-0.158	0.020	0.026
	(0.119)	(0.048)	(0.055)
Number of Girls in the Household	0.222*	-0.078	-0.090
	(0.129)	(0.055)	(0.062)
Number of Boys in the Household	0.122	-0.042	-0.049
	(0.136)	(0.056)	(0.064)
Household Size	0.003	0.013	0.015
	(0.062)	(0.029)	(0.033)
Dependency Ratio	0.219	-0.153	-0.168
	(0.602)	(0.254)	(0.288)
Household Head Single	-0.251	0.045	0.078
	(0.347)	(0.153)	(0.175)
Household Head Female	0.810*	-0.254	-0.319
	(0.413)	(0.189)	(0.220)
Household Head Migrant	0.117	0.054	0.045
	(0.256)	(0.122)	(0.139)
Household Head Age	0.000	0.003	0.004
	(0.014)	(0.006)	(0.007)
Household Head Education	-0.076***	0.022**	0.026**
	(0.024)	(0.011)	(0.012)
Household Head Agricultural Experience	-0.009	-0.004	-0.006
	(0.014)	(0.006)	(0.007)
Household Head Member of Farm Organization	0.039	-0.114	-0.151
	(0.189)	(0.093)	(0.106)
Days Agricultural Work Forbidden	0.002	-0.001	-0.001
	(0.003)	(0.001)	(0.001)
Household Income	-0.003	0.000	0.001
	(0.002)	(0.001)	(0.002)
Household Working Capital	-0.008	0.008***	0.010***
	(0.006)	(0.003)	(0.003)
Household Assets	-0.016***	0.005***	0.006***
	(0.004)	(0.002)	(0.002)
Household Landholdings	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)

"Yes" to $12.50 Investment (Imputed)	-0.432	0.124	0.144
	(0.410)	(0.178)	(0.203)
"Yes" to $25.00 Investment (Imputed)	-0.411	0.073	0.070
	(0.417)	(0.186)	(0.207)
"Yes" to $37.50 Investment (Imputed)	-0.288	-0.027	-0.023
	(0.322)	(0.161)	(0.189)
"Yes" to $50.00 Investment (Imputed)	0.544	-0.065	-0.065
	(0.397)	(0.180)	(0.204)
"Yes" to $62.50 Investment (Imputed)	-1.148**	0.375*	0.430*
	(0.498)	(0.216)	(0.242)
"Yes" to $75.00 Investment (Imputed)	0.084	-0.303	-0.328
	(0.409)	(0.193)	(0.219)
Constant	5.628***	-	-4.468***
	(1.146)		(0.606)
Observations	1,178	1,045	1,045
District Fixed Effects	Yes	Yes	Yes
R-squared	0.212	-	-

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A7. Estimation Results for Treatment Regression Specifications as in Bellemare (2012).

Variables	(1) No Imputations	(2) With Imputations
Dependent Variable: Duration of Hungry Season.		
Contract Farming Participant	-1.930**	-1.783*
	(0.893)	(0.986)
Household Size	0.070*	0.068*
	(0.036)	(0.037)
Dependency Ratio	0.448	0.460
	(0.391)	(0.389)
Household Head Single	-0.054	-0.056
	(0.359)	(0.355)
Household Head Female	0.452	0.476
	(0.434)	(0.437)
Household Head Migrant	0.077	0.073
	(0.245)	(0.243)
Household Head Age	0.010	0.011
	(0.012)	(0.012)
Household Head Education	-0.071***	-0.070***
	(0.024)	(0.024)
Household Head Agricultural Experience	-0.024**	-0.024**
	(0.011)	(0.011)
Household Head Member of Farm Organization	0.451*	0.420
	(0.270)	(0.285)
Days Agricultural Work Forbidden	-0.004	-0.004
	(0.002)	(0.002)
Household Income	-0.004**	-0.004**
	(0.002)	(0.002)
Household Working Capital	0.003	0.003
	(0.003)	(0.003)
Household Assets	-0.012***	-0.012***
	(0.003)	(0.003)
Household Landholdings	0.000	0.000
	(0.000)	(0.000)
Constant	4.756***	4.646***
	(0.821)	(0.866)
Observations	1,178	1,178
District Fixed Effects	Yes	Yes

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A8. Estimation Results for OLS, Cox Proportional Hazard, and Survival-Time Regressions. Monotonic Switching Enforced for the Contingent Valuation Responses; With Sampling Weights.

Variables	OLS	Cox	Survival Time
Dependent Variable: Duration of Hungry Season.			
Contract Farming Participant	-0.277*	0.166***	0.188***
	(0.145)	(0.063)	(0.071)
Household Size	0.052	-0.013	-0.015
	(0.036)	(0.015)	(0.017)
Dependency Ratio	0.517	-0.226	-0.247
	(0.366)	(0.158)	(0.181)
Household Head Single	-0.126	0.042	0.068
	(0.343)	(0.147)	(0.167)
Household Head Female	0.732*	-0.323*	-0.390*
	(0.402)	(0.175)	(0.202)
Household Head Migrant	0.064	0.014	0.009
	(0.219)	(0.101)	(0.115)
Household Head Age	0.021**	-0.003	-0.003
	(0.009)	(0.004)	(0.005)
Household Head Education	-0.068***	0.022**	0.026**
	(0.022)	(0.010)	(0.011)
Household Head Agricultural Experience	-0.029***	0.005	0.004
	(0.010)	(0.004)	(0.005)
Household Head Member of Farm Organization	0.091	-0.095	-0.125
	(0.183)	(0.088)	(0.100)
Days Agricultural Work Forbidden	-0.003	0.000	0.000
	(0.002)	(0.001)	(0.001)
Household Income	-0.004**	0.000	0.000
	(0.002)	(0.001)	(0.002)
Household Working Capital	0.002	0.006***	0.007***
	(0.003)	(0.002)	(0.002)
Household Assets	-0.013***	0.004***	0.005***
	(0.003)	(0.001)	(0.002)
Household Landholdings	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
"Yes" to $12.50 Investment (Monotonic Switching)	0.218	-0.033	-0.027
	(0.217)	(0.095)	(0.107)
"Yes" to $25.00 Investment (Monotonic Switching)	-0.614***	0.140	0.154
	(0.231)	(0.099)	(0.112)
"Yes" to $37.50 Investment (Monotonic Switching)	0.008	0.020	0.020
	(0.232)	(0.103)	(0.118)
"Yes" to $50.00 Investment (Monotonic Switching)	0.183	-0.144	-0.164
	(0.250)	(0.122)	(0.140)
"Yes" to $62.50 Investment (Monotonic Switching)	0.063	0.021	0.022

	(0.328)	(0.153)	(0.177)
"Yes" to $75.00 Investment (Monotonic Switching)	0.293	-0.229	-0.240
	(0.415)	(0.203)	(0.228)
Constant	3.793***	-	-4.152***
	(0.456)		(0.256)
Observations	1,178	1,045	1,045
R-squared	0.206	-	-

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A9. Balance Statistics for Matched Sample with One Nearest Neighbor and 0.01 Caliper

Variable	Treated Mean	Control Mean	Difference in Means	t-statistic
Household Size	5.768	5.572	0.196	1.240
Dependency Ratio	0.447	0.445	0.003	0.070
Household Head Single	0.083	0.109	-0.025	-0.630
Household Head Female	0.055	0.071	-0.016	0.110
Household Head Migrant	0.128	0.118	0.009	0.580
Household Head Age	42.548	42.920	-0.372	0.740
Household Head Education	5.988	6.014	-0.027	-0.360
Household Head Agricultural Experience	20.115	19.830	0.285	0.670
Household Head Member of Farm Organization	0.270	0.211	0.058	-0.130
Days Agricultural Work Forbidden	23.583	25.328	-1.745	0.240
Household Income	22.876	19.391	3.485	0.790
Household Working Capital	6.562	4.761	1.801	1.540
Household Assets	14.887	11.917	2.970	1.450
Household Landholdings	172.130	143.430	28.700*	1.890
District 1	0.177	0.173	0.004	0.000
District 2	0.241	0.239	0.003	-0.470
District 3	0.191	0.180	0.011	-0.220
District 4	0.137	0.147	-0.011	0.620
District 5	0.163	0.172	-0.009	0.140
District 6	0.090	0.089	0.001	0.030
"Yes" to $12.50 Investment	0.124	0.122	0.002	0.220
"Yes" to $25.00 Investment	0.179	0.183	-0.003	-0.910
"Yes" to $37.50 Investment	0.168	0.167	0.001	-0.360
"Yes" to $50.00 Investment	0.165	0.129	0.036	-0.110
"Yes" to $62.50 Investment	0.067	0.075	-0.008	-0.940
"Yes" to $75.00 Investment	0.087	0.065	0.022	0.780
"No" to Any Investment	0.209	0.259	-0.050	1.090

*** p<0.01, ** p<0.05, * p<0.1

Table A10. Balance Statistics for Matched Sample with Three Nearest Neighbors and 0.01 Caliper

Variable	Treated Mean	Control Mean	Difference in Means	t-statistic
Household Size	5.768	5.589	0.179	1.080
Dependency Ratio	0.447	0.445	0.003	-0.090
Household Head Single	0.083	0.121	-0.037	-1.160
Household Head Female	0.055	0.077	-0.022	-0.250
Household Head Migrant	0.128	0.108	0.020	0.670
Household Head Age	42.548	43.330	-0.782	-0.390
Household Head Education	5.988	5.948	0.039	0.620
Household Head Agricultural Experience	20.115	20.202	-0.087	-0.040
Household Head Member of Farm Organization	0.270	0.221	0.048	-0.820
Days Agricultural Work Forbidden	23.583	25.442	-1.859	0.170
Household Income	22.876	18.380	4.496	1.990
Household Working Capital	6.562	4.413	2.149**	2.170
Household Assets	14.887	12.192	2.695*	1.740
Household Landholdings	172.130	144.980	27.150*	1.890
District 1	0.177	0.187	-0.009	-0.550
District 2	0.241	0.229	0.012	0.450
District 3	0.191	0.169	0.023	0.380
District 4	0.137	0.154	-0.017	0.000
District 5	0.163	0.170	-0.007	0.080
District 6	0.090	0.091	-0.001	-0.530
"Yes" to $12.50 Investment	0.124	0.131	-0.007	-0.430
"Yes" to $25.00 Investment	0.179	0.176	0.003	-0.780
"Yes" to $37.50 Investment	0.168	0.148	0.021	0.590
"Yes" to $50.00 Investment	0.165	0.150	0.015	-1.020
"Yes" to $62.50 Investment	0.067	0.071	-0.003	-0.540
"Yes" to $75.00 Investment	0.087	0.067	0.020	-0.020
"No" to Any Investment	0.209	0.257	-0.048	1.620

*** p<0.01, ** p<0.05, * p<0.1

Table A11. Balance Statistics for Matched Sample with Three Nearest Neighbors and 0.001 Caliper

Variable	Treated Mean	Control Mean	Difference in Means	t-statistic
Household Size	5.790	5.645	0.145	0.850
Dependency Ratio	0.451	0.452	-0.001	-0.570
Household Head Single	0.082	0.104	-0.022*	-1.650
Household Head Female	0.059	0.073	-0.015	-1.250
Household Head Migrant	0.130	0.110	0.020	0.490
Household Head Age	43.039	42.690	0.349	0.690
Household Head Education	5.928	6.047	-0.119	0.160
Household Head Agricultural Experience	20.586	19.554	1.032	1.740
Household Head Member of Farm Organization	0.202	0.179	0.022	0.090
Days Agricultural Work Forbidden	23.928	25.273	-1.345	0.060
Household Income	19.707	16.242	3.465**	2.250
Household Working Capital	4.920	3.903	1.017*	1.700
Household Assets	13.511	11.726	1.785	1.140
Household Landholdings	158.990	134.460	24.530*	1.880
District 1	0.189	0.187	0.002	-0.020
District 2	0.243	0.236	0.007	0.590
District 3	0.171	0.176	-0.005	-1.100
District 4	0.137	0.148	-0.011	0.350
District 5	0.163	0.167	-0.004	-0.060
District 6	0.098	0.086	0.011	0.220
"Yes" to $12.50 Investment	0.132	0.132	0.001	-0.060
"Yes" to $25.00 Investment	0.178	0.197	-0.019**	-2.040
"Yes" to $37.50 Investment	0.178	0.162	0.016	0.950
"Yes" to $50.00 Investment	0.141	0.148	-0.007	-1.560
"Yes" to $62.50 Investment	0.067	0.074	-0.007	-0.120
"Yes" to $75.00 Investment	0.080	0.056	0.025	1.540
"No" to Any Investment	0.223	0.231	-0.008	1.470

*** p<0.01, ** p<0.05, * p<0.1