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Anette Ruml
Catherine Ragasa
Matin Qaim

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Heterogeneous effects of marketing contracts and resource-providing contracts on household income

Anette Ruml [1],* Catherine Ragasa [2] and Matin Qaim [1]

[1] Department of Agricultural Economics and Rural Development, University of Goettingen, 37083 Goettingen, Germany

[2] International Food Policy Research Institute (IFPRI), Washington D.C., USA

* Corresponding author: Anette Ruml; University of Goettingen; Heinrich-Dueker-Weg 12; 37073 Goettingen; Germany; Email: anette.ruml@uni-goettingen.de; Tel: +49551-3920212

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Abstract

In the existing literature, the effects of contract farming on household welfare were examined with mixed results. Most studies looked at single contract types. This paper contributes to the literature by comparing two types of contracts – simple marketing contracts and resource-providing contracts – in the Ghanaian oil palm sector. We investigate the effects of both contracts on farm income, as well as spillovers on other household income sources. We use survey data collected with an innovative sampling design and a control function approach to address possible issues of endogeneity. Both contracts lead to large positive effects on total household income in a similar magnitude, yet through quite different mechanisms. Farmers under the marketing contract use the increase in oil palm profits to transition out of agricultural production and into off-farm employment. Farmers under the resource-providing contract have a stronger dependency on income from oil palm, which is considerably more profitable under the contract. The findings underline that contract characteristics matter for the effects and that disaggregated analysis of different income sources is important to understand the underlying mechanisms.

1. Introduction

The participation of smallholder farmers in modern supply chains is considered a crucial contributor to rural economic development and poverty reduction. However, smallholder market access is usually limited due to inefficiencies in input and output markets, and farm production is associated with high levels of risk. Market failures and risk lead to an underinvestment in inputs, technologies, and higher-value crops (Barrett et al., 2012). Contract farming has emerged as an institutional response to market failures, with the potential to reduce risk, increase smallholder investments in inputs and technologies, and thus contribute to higher productivity and income (Eaton and Shepherd, 2001; Otsuka et al., 2016).

The existing literature examined effects of contract farming on revenues and profits of the contracted crops (Boldwig et al., 2009; Girma and Gardebroek 2015; Hernández et al., 2007; Jones and Gibbon, 2011; Kalamakar, 2012; Kanburi Bidzakin et al., 2019; Kumar et al., 2019; Mishra et al., 2018; Setboonsarng et al., 2008; Tripathi et al., 2005; Väth and Kirk, 2014), on agricultural income (Champika and Abeywickrama, 2014; Escobal and Cavero, 2012; Islam et al., 2019), and on total household income (Andersson et al., 2015; Bellemare, 2012; Cahyadi and Waibel, 2013; Maertens and Swinnen, 2009; Maertens and Vande Velde, 2017; Mwambi et al., 2016; Rao and Qaim, 2011; Saigenji and Zeller, 2009; Wang et al., 2014; Warning and Key, 2002). The results are mixed (for a more comprehensive overview see Bellemare and Bloem, 2018; Otsuka et al., 2016; and Ton et al., 2018). The empirical evidence is commonly derived from an assessment of the effects of one specific contract type. This approach neglects that different types of contracts may also have different effects. A substantial difference exists between simple marketing contracts that only offer a secure output market, and resource-providing contracts that additionally provide inputs and other technical services through interlinked credit schemes (Bijman, 2008). While some studies investigate the differences in effects across crops (Khan et al., 2019; Kumar and Kumar, 2008; Kumar et al., 2018; Miyata et al., 2009; Narayanan, 2014; Simmons et al., 2005) and

contracting companies (Nagaraj al., 2008; Ragasa et al., 2018), only little evidence exists on the heterogeneity of effects across contract types. Currently three studies exist that investigate the effects of different contract types on rice in Benin (Arouna et al., 2019), horticulture production in Kenya (Ashraf et al., 2009), and patty seed in Nepal (Mishra et al., 2016). All stated studies find only minor differences between the contracts, potentially due to the relatively low investments required in the production of the respective crops. To the best of our knowledge, there is no evidence on the effects of marketing contracts and resource-providing contracts in a high-value crop sector with relatively high initial investment requirements. Such a sector is potentially more suited to investigate these differences. Oil palm is one example of a capital-intensive crop that has recently gained in importance among smallholders in different parts of the world. In general, small-scale farmers often face financial constraints for the establishment and maintenance of oil palm plantations. These constraints can potentially be overcome with a suitable contract design. It thus has to be tested whether a simple marketing contract can enable farmers to make the required investments, or whether a resource-providing contract is better suited to overcome the capital constraints.

We perform a cross-contract comparison in the Ghanaian oil palm sector, which is dominated by small-scale producers. In particular, we provide empirical evidence on the effects of marketing contracts and resource-providing contracts on income from a high-value crop that requires relatively high initial investments. Moreover, we expand the analysis by investigating spillover effects of both contracts on the household's other income sources. Bellemare (2018) provides first evidence of spillover effects of contract farming on other income sources in Madagascar. He finds that the increase in income from the contracted crops comes with high opportunity costs. Households turn away from nonfarm activities, due to higher labor inputs in the production of the contracted crop. Little is known about these effects beyond the results of his study.

We contribute to the existing literature in two ways: (1) by estimating the effects of marketing contracts and resource-providing contracts on income in a high-value crop sector, and (2) by investigating the spillover effects of both contracts on the household's other income sources. Investigating these effects will contribute towards a better understanding of suitable contract designs, which can lead to higher incomes for smallholder farmers.

We perform this analysis with cross-sectional data on farmers with marketing contracts, resource-providing contracts, and no contracts. Previous findings indicate differential effects of both contracts on the adoption of agrochemical inputs, specialization, production expansion, productivity (Ruml and Qaim, 2019a), and agricultural labor use (Ruml and Qaim, 2019b). The results here indicate different effects on farm income and other income sources.

We use an innovative sampling design and a control function approach to address possible issues of unobserved heterogeneity across oil palm producers. For the control function approach we use two village-level instruments related to the behavior of the village leader and other farmers in the same village. We analyze the effects of both types of contracts on oil palm profits, profits from other cash crops and livestock, income from off-farm wage employment and self-employment, and total household income.

To confirm the robustness of the results we re-estimate the models including (1) a willingness-to-pay and a risk preference measure to control for remaining unobserved heterogeneity across groups, and (2) inverse probability of treatment weights. Our results are robust to all model specifications and estimation techniques. We find that both contracts lead to a similar effect on total household income, but through different pathways. Farmers under the marketing contract reduce their agricultural production and generate more income off-farm. Farmers under the resource-providing contract increase their dependency on the more profitable oil palm production, which drives the increase in total household income.

The paper is structured as follows: Section 2 describes the set-up of the study and both contract farming schemes, including a review of previous findings on their effects. Section 3 describes materials and methods used in the analysis. Section 4 presents and discusses the empirical results; and section 5 concludes.

2. Background: Oil palm contract farming in Ghana

2.1.The Ghanaian oil palm sector

In Ghana, oil palm is a traditional crop that was – until recently – mainly produced for home consumption. However, with the rising national and international demand for vegetable oils, Ghana has increased its oil palm production to commercial scale (Byerlee et al., 2017). Several large national and international processing companies are now located in the south of the country, to process oil palm fruit bunches into palm oil. These companies typically have large own plantations (nucleus estates) and additionally procure supply from farmers through contractual agreements (Huddleston and Tonts, 2007; Ministry of Food and Agriculture, 2011). The farmers are mostly small-scale producers (1-39 acres), who persist to dominate the Ghanaian oil palm sector and produce 75 percent of the total supply (Byerlee et al., 2017).

Despite its economic importance and the large areas dedicated to the cultivation of oil palm, Ghana remains a net importer of palm oil, with local consumption exceeding production. While agroecological factors are favorable for oil palm production (Rhebergen et al., 2016), institutional factors pose challenges for small-scale producers. In the past, smallholders lacked a sufficiently large and reliable market outlet to incentivize increased production (Ministry of Food and Agriculture, 2011). Hence, the new marketing channels established by the contracting companies, which regularly purchase oil palm fruit bunches in large quantities and at stable prices, improve the situation and could contribute to gradually increasing supply. Under the marketing contracts, product sales are arranged in advance through contractual agreements, which substantially reduce the market risk for farmers.

Farmers often also lack access to the capital required for the establishment of an oil palm plantation and for the required production inputs (Ministry of Food and Agriculture, 2011). Plantation establishment is costly, and larger revenues start to flow only after 4 years or more (Baumann, 2000; Byerlee et al., 2017). Hence, farmers require access to longer-term credits. Under resource-providing contracts, the contracting companies supply farmers with credits for the establishment and maintenance of the plantation. These credits are paid back by the farmer through a share of the harvest that is supplied to the company without payment (or reduced payment). In addition to providing farmers with a secure sales market, these contracts directly address smallholder credit constraints. In the following, we introduce two contract farming schemes in the oil palm sector in Ghana: one marketing contract scheme and one resource-providing contract scheme.

2.2.The marketing contract scheme

The marketing contract in our study region is a verbal agreement between the processing company and the farmer, specifying an annual fixed price and regular pick-ups of the harvested oil palm fruit bunches. The processing company is the Benso Oil Palm Plantation (BOPP), a subsidiary of Wilmar International. The company cultivates a 4700 hectare nucleus estate and procures oil palm from contracted smallholders through middlemen that pick up the harvest at the farm gate. Farmers are paid for the harvest a few weeks after pick-up. Quality standards are very low and basically not existing. Farmers did not report about any rejections from the company. Only in peak seasons, it sometimes takes the company somewhat longer to pick up and weigh the harvest. During the waiting period, the fruit bunches lose water and hence weight, which reduces farmers' revenues.

Beyond these sales to the company at a fixed annual price, the marketing contract specifies no conditions and the farmers do not receive assistance. However, the company renovated the roads connecting the processing plant and some of the contracted villages to

reduce transportation costs. This infrastructure development is potentially an additional benefit for all farmers in the villages, regardless of whether or not they are contracted themselves. Considering that the marketing contract does not include any credits, entering the scheme is relatively easy for farmers. A few farmers in the study region joined the marketing contract scheme in the 1980s, the early years of the scheme. Most other farmers joined in the 1990s and early-2000s.

We find that the marketing contract leads to a reduction in the number of cash crops produced by the households, but not to the adoption of agrochemical inputs or to higher yields (Ruml and Qaim, 2019a). The company regularly collects the oil palm bunches, which means that the household does not have to pick the oil palm fruits out of the bunches, manually process the oil palm into palm oil, or market the produce, all of which is necessary when supplying traditional local markets. We find that the marketing contract leads to a significant reduction of agricultural labor use per acre, of over 50 percent on average. Households react to the lower labor requirement by reallocating household labor towards off-farm wage and self-employment (Ruml and Qaim, 2019b). Based on these previous findings we expect that the marketing contract reduces the income derived from cash crops other than oil palm (negative spillover), but increases the income from off-farm wage and self-employment (positive spillover).

2.3.The resource-providing contract scheme

The resource-providing contract in the study region is a written agreement between the processing company and the farmer, specifying an annual fixed price, regular pick-ups of the harvested oil palm, and in-kind credit provisions. The processing company is the Twifo Oil Palm Plantation (TOPP) which includes a 4300 hectare nucleus estate and is owned by Unilever. The in-kind credits include the required inputs for the establishment and the maintenance of the plantation. The credit is not a lump sum, but depends on the services the

farmer requires, e.g. the amount of labor and the machinery that the company provides. The credit is paid back by the farmer through 25 percent of each harvest, with interest rates. The farmer has full decision autonomy on the inputs he/she applies and the amount of credit, meaning that the production intensities are not pre-determined by the company. Output quality standards are low, but weight losses due to waiting times can occur in the peak seasons in the same way as discussed above for the marketing contract. The establishment of most plantations contracted under the resource-providing scheme was between 2008 and 2010. Similar to the marketing scheme, the company renovated the roads connecting the processing plant and some of the contracted villages to reduce transportation costs.

We find that the resource-providing contract leads to a specialization on oil palm through the expansion of the area under cultivation. Under the resource-providing contract, farmers sometimes acquire additional land to increase the production of oil palm. They also adopt chemical fertilizer and have a substantially higher productivity (Ruml and Qaim, 2019a). As the marketing contract, the resource-providing contract leads to a strong decrease in the agricultural labor use per acre. However, the reallocation of household labor towards off-farm employment is smaller, as farmers expand the area under (oil palm) cultivation, which leads to lower labor savings at the farm level. On average, we find an annual increase of 83 additional labor days worked in off-farm employment by male household members (Ruml and Qaim, 2019b). Whether the higher productivity and the increased production scale create revenues that are large enough to offset the additional costs and credit repayment rates will be tested in the following analysis.

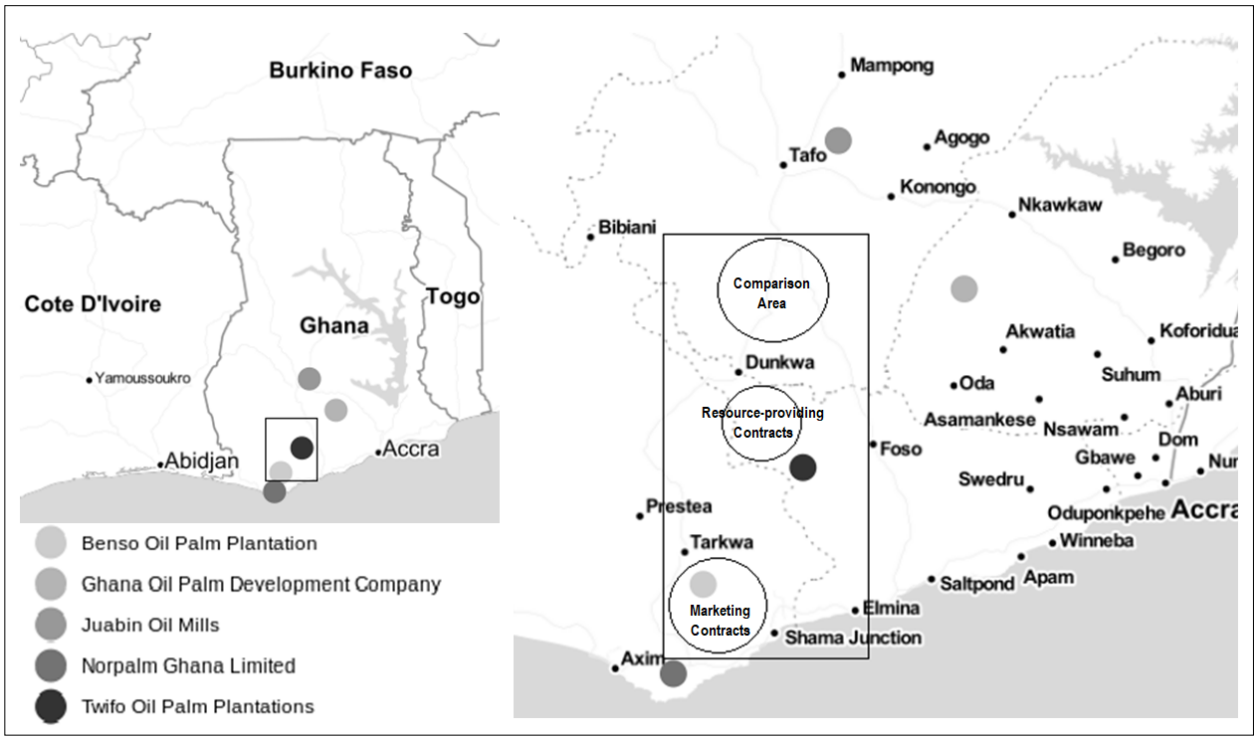
3. Material and methods

3.1.Data and sampling design

We collected cross-sectional data between April and July 2018. Out of five large processing companies in the region, we selected two based on their contract types and the geographical proximity to each other (see Figure 1). For comparison, we selected a region that is currently outside of the companies' catchment areas. A contract farming scheme is currently developed and scheduled for implementation in this comparison region, yet the farmers in that region were unaware of the upcoming scheme at the time of the survey. The Ministry of Food and Agriculture (MoFA) provided us with the list of villages selected for the new scheme. In these villages, the contracting company will offer contracts in the near future.

We decided to sample farmers from a comparison region rather than non-contracted farmers in the contract regions themselves, in order to reduce issues of selection bias and possible spillover effects of the contract schemes to non-contracted households. Spillovers may occur because also non-contracted farmers in the contract villages can sell their produce to the contracting company in times of supply shortages, or through the account of a contracted neighbor. Especially for the marketing contract, both cases were regularly reported in focus group discussions that we had organized. The independent producers in the contract villages are few in numbers and they declined the contract offer, which was also available to them. This raises concerns of selection bias from the farmer side. Surrounding villages without contracted farmers were not chosen by the contracting companies, so that sampling control farmers in these surrounding villages might have been associated with selection bias from the company side. This is why we decided to select a different comparison region, which is similar in terms of many relevant variables only that no contract scheme existed at the time of the survey.

Figure 1: Study area with contract and comparison regions



Note: Self-developed map based on Kahle and Wickham, 2013.

The three selected regions (one for each contract type and one comparison region) are bordering each other, as illustrated in Figure 1. The farmers under the marketing contract are located in the Western Region, the farmers under the resource-providing contract in the Central Region, and the comparison farmers in the Ashanti Region. All three regions are very similar in terms of their agroecological conditions and their suitability for oil palm cultivation (Rhebergen et al., 2016). Regional borders are informal and the population is alike in terms of its ethnic and religious composition.

The villages within the three regions were selected based on the lists provided by the contracting companies, and the MoFA. We randomly sampled 9 villages under the marketing contract, 13 villages under the resource-providing contract, and 9 comparison villages registered for the upcoming contract farming scheme. Within the sampled villages, a local interviewer team compiled lists with all households eligible for this study. This includes the contracted households in the contracted villages, and commercial oil palm farming households in the comparison villages. All households listed produce oil palm on their own

lands or under private land arrangements (e.g. sharecropping). Based on these lists we randomly sampled and interviewed 75 percent of the households in each village, using a structured questionnaire programmed into tablet computers. In total, this added up to 463 households, of which 193 produce under the marketing contract, 164 under the resource-providing contract, and 106 without any contract.

3.2.Estimation strategy

The objective of this paper is to estimate the effects of the marketing contract and the resource-providing contract on household income in total, and by income source. We model the estimation in equation (1), where Y_{hj} denotes the respective per capita income of household h in village j, for the last 12 months prior to the survey. MC_{hj} and RPC_{hj} denote two treatment dummies that equal one if the household is contracted under the marketing contract (MC) and the resource-providing contract (RPC), respectively.

$$lnY_{hj} = \beta_0 + \beta_1 MC_{hj} + \beta_2 RPC_{hj} + \beta_3 X_{hj} + u_{hj} \quad (1)$$

To derive relative changes, lnY_{hj} denotes the inverse hyperbolic sine transformation of Y_{hj}. This transformation is more suited to account for zeros and negative values among the observations, as suggested by Bellemare and Wichman (2019). After estimation, we calculate semi-elasticities, such that β_1 and β_2 present the marginal effects of the respective contract scheme on the household's per capita income in percentage terms.

The income categories under investigation include the household's oil palm profits, other cash crop profits, livestock income, income from off-farm wage and self-employment, and total household income. Oil palm profits are calculated as the total revenues made from oil palm minus all input and transportation costs. Household labor was not valued for this calculation, so that the profit can be interpreted as the return to household labor. For farmers under the resource-providing contract, the credit repayment rates were deducted as variable costs. Other cash crop profits and livestock income were calculated in the same way.

Livestock is a minor income source in the study setting, yet we include it for completeness. The income from off-farm wage and self-employment is the sum of all annual salaries/wages and profits from non-farm enterprises. Lastly, total household income is the sum of all the different income sources. To account for differences in household structures, per capita incomes were derived using the Oxford Equivalent Scale.

Collecting credible data on household income requires an elaborate set of questions and the ability of farmers to recall the required information. For the profits from oil palm and other cash crops we split the questions into plots and types of crop; we asked each sale and input expenditure for each crop on each plot separately. For the hired labor expenditure for oil palm we continued this separation and additionally split the questions into production steps and the type of labor hired (male and female adult, child and youth), to get accurate wages and working hours. Income from off-farm wage and self-employment was easier to collect, as households typically have very few off-farm income sources (if any) and with relatively little variation over the year. For the profits of self-employment, the interviewer team assisted the household in calculating monthly profits and adding them up to annual values.

3.3.Identification strategy

Estimating the effects of contract farming with cross-sectional data raises concerns of endogeneity (unobserved heterogeneity and reverse causality). Cross-sectional data limit the ability to observe changes in the outcome variables for the same unit of observation over time; and modelling the variation across different units risks capturing the unobserved heterogeneity across these units and not the effect of the treatment. In equation (1), this implies a possible correlation between the contract participation variables and the error term, which violates the assumptions of the OLS model and leads to inconsistent and biased results. Endogeneity is also likely since income level can affect contract participation. The two dummy variables measuring the participation in the marketing contract and the resource-

providing contract may be endogenous to the income model. There is also the potential issue of non-random self-selection of farmers into the respective contract farming scheme (Bellemare, 2012). We use a set of strategies to reduce such issues of endogeneity. First, the set-up of the study and the sampling strategy were chosen such that they reduce the risk of selection bias. As described above, we only considered villages that are eligible for contracting from the company perspective and included comparison farmers that have not yet made the participation decision.

Second, we use propensity score matching to ensure the comparability of the farmers with and without contracts. We calculate propensity scores based on a multinomial logit model (for the two contract options and the control), and restrict the analysis to the households with common support. In total, three households with marketing contracts are excluded from further analysis. The three households have no common support, under both the nearest neighbor matching (NNM) and the kernel matching (KM).

Third, we address endogeneity by using instruments that explain contract participation but do not directly influence income beyond the effect through contract participation. The instrument for the marketing contract is the share of oil palm producing households in the village. Due to the high transportation and transaction costs of the processing companies, a village is more likely to be involved in the contract scheme if a large share of farmers produce oil palm. The marketing scheme does not provide financial assistance to the farmers and the company is dependent on farmers with established oil palm plantations. Thus, we expect that a higher share of commercial oil palm farmers in a village will increase the chance of a farmer being targeted by the contract scheme. The share of commercial oil palm farming households in the village does not directly influence the household's total income, or any of the income sources.

The instrument for the resource-providing contract is a dummy variable that equals one if the village chief is a commercial oil palm farmer. In this set-up, the village chief acts as

an intermediary between the contracting company and the farmers within the village. We argue that the village chief is more likely to cooperate with the company if being a commercial oil palm farmer himself/herself. Again, the instrument has no direct influence on the household's incomes, considering that we only measure whether the village chief produces oil palm and not how he/she produces it.

Using these instruments, we employ a control function (CF) approach, which is efficient also when the first-stage equation is nonlinear, as in our case (Terza et al., 2008; Wooldridge, 2014). In our CF model, contract participation is estimated in a first step, based on which the residuals for each treatment are calculated (Terza et al., 2008; Wooldridge, 2014). Equations (2) and (3) describe this procedure.

$$C_{hj} = \propto_0 + \propto_1 X_{hj} + \propto_2 Z_j + v_{hj} \quad (2)$$

$$\hat{v}_{hj} = C_{hj} - \hat{C}_{hj} \quad (3)$$

where C_{hj} is a binary variable that equals one if the household is under contract and zero otherwise, X_{hj} captures the exogenous household and village level controls, and Z_j is the vector of instruments described above. Since we have two different contract farming schemes, the underlying model in equation (2) is a multinomial logit model.

We include the two described instruments that are exogenous to the household's per capita incomes and sufficiently explain the participation in the respective contract farming scheme in the multinomial logit model. Both instruments pass the exclusion restriction, as illustrated in Table A1 in the appendix. Both instruments have no correlation with any of the outcome variables in the control group. This indicates that they have no direct effect on the outcome variables, other than through contract participation. Furthermore, they sufficiently explain participation in the respective contract farming scheme, as illustrated in Table A2 in the appendix. Both instruments are statistically significant at the one percent level in the reduced form of the marketing contract. Further, the results of the Anderson and Cragg-Donald tests suggest that the instruments are not under-identified and not weak.

After estimation, we derive the residuals $\hat{v}_{hj}$ through the difference between actual participation C_{hj} and estimated participation $\hat{C}_{hj}$ in the respective contract scheme, as described in equation (3). Based on these residuals, we calculate generalized residuals, which are normalized and have a conditional mean at zero (Gourieroux et al., 1987; Wooldridge, 2015). These generalized residuals are included in the regressions in a second step. If they are statistically significant, exogeneity has to be rejected and the residuals are included to control for endogeneity. If the residuals are statistically insignificant, exogeneity cannot be rejected, and OLS without further inclusion of the residuals can be applied.

In our case, we find no statistical significance of the residual terms and hence cannot reject exogeneity for all model specifications, as illustrated in Table A3 in the appendix. Thus, OLS estimations are consistent and will be employed.

We further perform two robustness checks to verify the results. First, we include a willingness-to-pay and a risk preference measure in all model specifications. The self-selection of farmers into contract farming is based on unobservable characteristics, such as their entrepreneurial ability, or their risk and time preferences. A systematic difference in these unobservables between contracted and non-contracted farmers would lead to a correlation with the error term and bias in the OLS results (Angrist and Pischke, 2008), as described above. The household's willingness-to-pay for contracting and risk preferences are likely correlated with entrepreneurial ability and other relevant unobserved factors, so that including these indicators can test for possible bias due to unobserved heterogeneity. A similar approach was applied in Bellemare and Novak (2017), Meemken and Qaim (2018), and Verhofstadt and Maertens (2014) to test and control for unobserved heterogeneity. In our study, the willingness-to-pay measure was derived through a set of hypothetical contract offers with required initial investments. The variable captures the highest initial investment the farmer was willing to make, to participate in a contract. The risk preferences were measured through a set of choices, in which the farmer decided between a lower risk and a

higher risk crop. Our risk variable represents these choices in categorical form, ranging from 0 (risk averse) to 5 (risk friendly). We include both measures as a robustness check, to test whether the OLS results are robust to this modification.

As a second robustness check, we perform an inverse probability of treatment weighting (IPTW) to control for pre-treatment imbalances (McCaffrey et al., 2013). In a first step, we estimate the probability of a household being under the marketing contract or the resource-providing contract, based on a multinomial logit model. In a second step, we use the inverse probabilities as weights in the OLS regression. Thus, each household in the sample is assigned a weight that expresses the likelihood that the household would be under contract. This way, a non-contracted household with a high probability to be under contract contributes more to this analysis compared to a household with a low probability. For the contracted farmers, the weights have the opposite effect. This approach further increases the comparability of the three groups.

It should be stressed that impact evaluation with cross-section observational data remains a challenge, where possibly not all issues of endogeneity can be solved. Another limitation that should be mentioned is that the marketing contract and the resource-providing contract are offered by two different companies. Hence, we are not able to separate the contract effects from company characteristics or other company services (such as infrastructure improvements) that may also play a role. Results should therefore be interpreted as the total package of contracts, services, and infrastructural support to the contract regions/villages. Despite these limitations, the results across the estimation and identification techniques are consistent, which provides confidence on the validity of the findings.

4. Results

4.1.Descriptive results

Table 1 compares oil palm profits and related variables across contract and comparison groups. Mean differences between the three groups are tested for statistical significance. Mean revenues and profits are higher for farmers under the marketing contract than for non-contract farmers, whereas production costs are lower. However, these differences are not statistically significant, due to large data variability, especially in the group of non-contract farmers. Farmers under the resource-providing contract cultivate a larger area of land with oil palm and have substantially higher yields, revenues, and profits than the other two groups, and these differences are statistically significant.

Table 1: Descriptive results – oil palm profitability

	Mean			Difference		
	Marketing contract (MC)	Resource-providing contract (RPC)	No contract (NC)	MC-RPC	MC -NC	RPC-NC
Total area under oil palm (in acres)	4.59	8.02	5.05	***		***
	(0.28)	(0.62)	(0.53)			
Total yields (in tons)	13.90	43.08	13.08	***		***
	(1.19)	(5.32)	(1.96)			
Revenues (in GHS)	4604.69	10017.24	4267.88	***		***
	(398.41)	(1236.50)	(931.31)			
Production costs acre (in GHS)	2548.50	3931.67	3650.16	**		
	(224.32)	(559.84)	(1032.82)			
Price per ton of oil palm (in GHS)	337.28	310.06	422.02	***	***	***
	(3.46)	(0.03)	(38.13)			
Average profits per acre	399.55	738.88	205.56	***		***
	(60.00)	(65.10)	(138.05)			
Total profits	2056.20	6085.67	617.73	***		***
	(343.97)	(902.79)	(1179.12)			

Note: GHS refers to Ghanaian Cedis. Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Farmers in both contract groups receive significantly lower output prices than non-contract farmers. Apparently, the security provided by the contracts and the ability to sell larger quantities comes with a lower average price per ton of fruit bunches. Yet, the variability of the output prices is also substantially lower in both contract schemes. Independent producers have a variety of market outlets, including small processors and local consumers,

who purchase either small quantities of oil palm fruits or manually processed palm oil. Hence, spot market prices depend on fluctuating demand and can vary substantially. Although independent producers receive a higher mean price per ton, they can usually not sell in larger quantities.

Table 2 compares mean per capita incomes across the three groups. Compared to non-contract farmers, farmers under the marketing contract have higher oil palm profits, lower profits from other cash crops, lower income from livestock and off-farm employment, and lower total household incomes. However, these differences are not statistically significant. The results in the lower part of Table 2 further indicate that farmers under the marketing contract derive a lower share of their income from oil palm and a higher share from other cash crops and off-farm wage and self-employment.

Farmers under the resource-providing contract have much higher oil palm profits than the other two groups and these differences are statistically significant (Table 2). This difference in oil palm profits seems to over-compensate lower incomes from other sources, resulting in higher total household incomes per capita among farmers with a resource-providing contract. These simple comparisons should not be over-interpreted, but they suggest that the contracts may not only influence the income magnitude, but may also lead to shifts in the role of different income sources. Descriptive statistics for the variables that are used as controls in the regression models are shown in Table A5 in the appendix.

Table 2: Descriptive results – per capita income, by income source

	Mean			Difference		
	Marketing contract (MC)	Resource-providing contract (RPC)	No contract (NC)	MC-RPC	MC -NC	RPC-NC
Oil palm profits (in GHS)	812.26	2196.28	299.38	***		***
	(146.43)	(440.56)	(339.69)			
Profits from other cash crops (in GHS)	1565.20	1540.87	2138.76			
	(215.77)	(212.87)	(903.45)			
Livestock income (in GHS)	29.39	44.79	43.38			
	(12.21)	(16.32)	(14.24)			
Income from off-farm wage and self-employment (in GHS)	623.08	638.75	1019.39			
	(83.56)	(169.28)	(350.98)			
Total household income (in GHS)	3029.93	4657.72	3500.91	**		
	(313.39)	(649.43)	(923.29)			
Income shares						
Oil palm profits (in GHS)	0.38	0.72	0.43			
	(0.06)	(0.18)	(0.13)			
Profits from other cash crops (in GHS)	0.33	0.14	0.29			
	(0.05)	(0.18)	(0.08)			
Livestock income (in GHS)	0.01	0.01	0.02			
	(0.00)	(0.00)	(0.01)			
Income from off-farm wage and self-employment (in GHS)	0.20	0.13	0.14	*		
	(0.03)	(0.03)	(0.07)			
Share of households with positive oil palm profits	0.77	0.84	0.60		***	***
	(0.03)	(0.03)	(0.05)			
Share with positive profits for other cash crops	0.78	0.82	0.81			
	(0.03)	(0.03)	(0.04)			
Share of household with livestock income	0.13	0.16	0.21			
	(0.02)	(0.03)	(0.04)			
Share of households with off-farm wage and self-employment	0.49	0.46	0.48			
	(0.04)	(0.04)	(0.05)			

Note: Additional descriptive statistics are presented in Table A4 in the appendix. Descriptive statistics of the control variables are presented in Table A5 in the appendix. Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

4.2.Econometric results

Table 3 presents the OLS results of the effects of contract participation on per capita income after controlling for confounding factors. We focus on the semi-elasticities shown in the lower part of Table 3 for easy interpretation. According to these estimates, the marketing contract leads to a 95 percent increase in per capita oil palm income. Further, we identify spillover effects of the marketing contract on other income sources: we find a 9 percent reduction in profits from other cash crops, an 18 percent reduction in livestock income, and an 11 percent increase in income off-farm wage and self-employment. The net effect of the marketing contract on total per capita household income is a 67 percent increase. Overall, these results suggest that the oil palm marketing contract leads to very sizeable income gains and also

contributes to a certain transition of farm households towards off-farm economic activities. A stronger emphasis on off-farm activities is possible because of the significant labor savings associated with the contract (Ruml and Qaim, 2019b), as discussed above.

The results for the resource-providing contract show a 139 percent increase in oil palm profits (Table 3), which is substantially larger than the effect of the marketing contract. Furthermore, we find a positive spillover effect of the resource-providing contract for oil palm on profits from other cash crops in a magnitude of 8 percent. The positive profit effect for other cash crops points at productivity gains across the different crops produced; at least it cannot be the result of larger areas grown with other cash crops, because farmers under the resource-providing contract actually specialize more on oil palm and grow smaller areas with other cash crops than non-contracted farmers (Ruml and Qaim, 2019a). Livestock income is reduced by 15 percent through the resource-providing contract, whereas income from off-farm wage and self-employment is not affected significantly. The net effect of the resource-providing contract on total per capita household income is a 70 percent increase.

Table 3: OLS results – per capita income, by income source

	Oil palm profits	Profits other cash crops	Livestock income	Income off-farm wage and self-employment	Total household income
Marketing contract	2.29***	-0.22*	-0.43**	0.27**	1.63***
	(0.22)	(0.06)	(0.07)	(0.06)	(0.05)
Resource-providing contract	3.90***	0.23	-0.42**	0.16	1.96**
	(0.07)	(0.14)	(0.06)	(0.11)	(0.25)
Other controls included	Yes	Yes	Yes	Yes	Yes
Semi elasticities					
Marketing contract	0.95***	-0.09***	-0.18***	0.11***	0.67***
	(0.09)	(0.02)	(0.03)	(0.02)	(0.02)
Resource-providing contract	1.39***	0.08*	-0.15***	0.06	0.70***
	(0.03)	(0.05)	(0.02)	(0.04)	(0.09)
Observations	460	460	460	460	460

Note: Full regression results are presented in Table A6 in the appendix. Treatment clustered standard errors in parentheses.
* p < 0.1, ** p < 0.05, *** p < 0.01

The control function estimates are shown in Table 4. These are very similar to the OLS estimates just discussed, which underlines the robustness of the findings. The only major

difference is that with the control function approach we do not find statistically significant effects of both contracts on profits from other cash crops.

Table 4: Control function results – per capita income, by income source

	Oil palm profits	Profits other cash crops	Livestock income	Income off-farm wage and self-employment	Total household income
Marketing contract	2.35**	-0.17	-0.39**	0.38	2.37**
	(0.27)	(0.16)	(0.08)	(0.15)	(0.40)
Resource-providing contract	4.08**	-0.01	-0.57**	0.56	1.94**
	(0.67)	(0.32)	(0.09)	(0.25)	(0.21)
Other controls included	Yes	Yes	Yes	Yes	Yes
Semi elasticities					
Marketing contract	0.97***	-0.07	-0.16***	0.13*	0.98***
	(0.11)	(0.06)	(0.03)	(0.07)	(0.17)
Resource-providing contract	1.45***	-0.01	-0.20***	0.06	0.70***
	(0.24)	(0.11)	(0.03)	(0.04)	(0.07)
Observations	460	460	460	460	460

Note: Full regression results are presented in Table A7 in the appendix. Treatment clustered standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4.3.Robustness checks

We now present the results of the two robustness checks that were described above in connection with the identification strategy. Table 5 presents the results of models that include the farmers' willingness-to-pay for contracting and risk preferences as additional explanatory variables to control for unobserved heterogeneity. The estimates are very similar to the OLS results above in terms of both their magnitude and statistical significance. Only the effect of the resource-providing contract on profits from other cash crops is not statistically significant.

Table 5: OLS results – per capita income, by income source (including willingness-to-pay and risk preferences)

	Oil palm profits	Profits other cash crops	Livestock income	Income off-farm wage and self-employment	Total household income
Marketing contract	2.31**	-0.27**	-0.43**	0.33**	1.64***
	(0.24)	(0.06)	(0.07)	(0.03)	(0.03)
Resource-providing contract	3.95***	0.20	-0.40**	0.20	1.98**
	(0.10)	(0.14)	(0.05)	(0.16)	(0.24)
Other controls included	Yes	Yes	Yes	Yes	Yes
Semi elasticities					
Marketing contract	0.96***	-0.11***	-0.18***	0.14***	0.68***
	(0.10)	(0.03)	(0.03)	(0.01)	(0.01)
Resource-providing contract	1.40***	0.07	-0.14***	0.07	0.71***
	(0.03)	(0.05)	(0.02)	(0.06)	(0.08)
Observations	460	460	460	460	460

Note: Full regression results are presented in Table A8 in the appendix. Treatment clustered standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01

Table 6 presents the results of the models with inverse probability weighting. Again, the effects are similar to the OLS results. In fact, using the inverse probability weights increases the magnitude of some of the coefficients. Overall, we conclude that the main findings are quite robust to changes in the estimation strategy.

Table 6: OLS results – per capita income, by income source (inverse probability of treatment weighting)

	Oil palm profits	Profits other cash crops	Livestock income	Income off-farm wage and self-employment	Total household income
Marketing contract	2.07***	-0.45**	-0.37***	0.65*	1.31***
	(0.04)	(0.05)	(0.01)	(0.15)	(0.06)
Resource-providing contract	3.99***	0.08*	-0.45***	0.32	1.97***
	(0.17)	(0.03)	(0.02)	(0.22)	(0.15)
Other controls included	Yes	Yes	Yes	Yes	Yes
Semi elasticities					
Marketing contract	0.86***	-0.18***	-0.15***	0.27***	0.54***
	(0.02)	(0.02)	(0.00)	(0.06)	(0.02)
Resource-providing contract	1.65***	0.03***	-0.19***	0.13	0.81***
	(0.07)	(0.01)	(0.01)	(0.09)	(0.06)
Observations	460	460	460	460	460

Note: Full regression results are presented in Table A9 in the appendix. Treatment clustered standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01

5. Discussion and policy implications

5.1. Discussion of results

The results show that both the marketing contract and the resource-providing contract lead to significant increases in oil palm profits and total household incomes. The effect on oil palm profits is larger for the resource-providing contract, while the effect on total household income is similar for both contracts. The effects were found to be robust to a variety of model specifications and estimation techniques.

The findings suggest that while marketing contracts and resource-providing contracts lead to similar effects on total household income, the impact mechanisms of both contracts are quite different. We find that farmers under the marketing contract use the gain in oil palm profits and the saved labor time to transition out of agricultural production. While oil palm remains an important income source for these farmers, the production of other cash crops and livestock decreases and the income from off-farm wage and self-employment increases. These results are quite different from those of Bellemare (2018), who finds that contracted smallholders turn away from nonfarm activities due to higher labor use for the contracted crop. Obviously, the effects depend on the type of crop and how the labor requirements change through contracting. For oil palm in Ghana, production under contract leads to a substantial reduction in agricultural labor use (Ruml and Qaim, 2019b).

Households producing under the resource-providing contract react quite differently. The provision of in-kind credits entails a large expansion of their oil palm plantations and a significant increase in productivity and profits. For households with a resource-providing contract, oil palm is by far the most important source of income and we find no indication of a significant transition towards off-farm economic activities.

5.2. Policy implications

Our findings suggest that the effects of contract farming strongly depend on the type of contract. This has important policy implications, depending on what the concrete policy objective is. If the main policy objective is to help farmers overcome their constraints in accessing credit, inputs, and technologies, and thus increase their farm incomes, resource-providing contracts are better suited than marketing contracts. Previous research suggests that marketing contracts alone may not be sufficient to increase smallholders' input and technology constraints (Ruml and Qaim, 2019a). However, if the main policy objective is to improve the wellbeing of smallholders – not necessarily only through farm income gains but through total household income gains, including from off-farm activities – marketing contracts may also serve the purpose, as our results from Ghana suggest.

Of course, the concrete results from the oil palm sector in Ghana cannot be generalized, as the outcomes depend on the type of crop, the type of market failures, and the agricultural and non-agricultural opportunities in a particular context. But the general finding that contract design matters substantially for the impact and the underlying impact mechanisms is certainly valid beyond the case of oil palm in Ghana.

5.3. Study limitations

Our study has two limitations. First, the potential issue of endogeneity that we addressed with a control function approach. The instruments used are at the village level and do not capture individual unobserved heterogeneity. Therefore, in a robustness check we tried to control for some of the possibly remaining unobserved heterogeneity through willingness-to-pay and risk preference measures. Furthermore, we increased comparability of farmers in the different contracts and the comparison group through inverse probability of treatment weighting. Our results are robust to these alternative specifications. Nevertheless, we may not have fully addressed all unobserved heterogeneity at the household level. Hence, some caution in the

causal interpretation is warranted. Second, we included two companies and contracts in our sample to estimate the effects of each type of contract. With this sampling strategy we are not able to separate the contract effects from potential effects of company characteristics. Separating these effects would require an alternative sampling strategy, which might be an interesting direction for future research.

6. Concluding remarks

In this paper, we have examined the effects of marketing contracts and resource-providing contracts in the Ghanaian oil palm sector. We have estimated the effects of both contracts on total household income and on different income sources. We have contributed to the existing literature in two ways: First, by performing a cross-contract comparison, which is useful to better understand the role of contract characteristics. To the best of our knowledge, this is the first study that compares effects of different types of contracts for a high-value crop in a developing country. Second, by analyzing the effects of both contracts on all farm and non-farm income sources, which is useful to identify spillovers and indirect effects that are not obvious when only focusing on profits from the contracted crop alone.

We have used a comprehensive identification strategy to reduce issues of endogeneity and also carried out various robustness checks. The results suggest that marketing contracts and resource-providing contracts both lead to large increases in total household income, yet through different mechanisms. Farmers under the marketing contract use the increase in oil palm profits to transition out of agricultural production. While oil palm remains an important income source for them, the income from other cash crops and livestock decreases and the income from off-farm wage and self-employment increases. Households producing under the resource-providing contract react in a different way. The provision of in-kind credits leads to a significant increase in oil palm profits and a stronger dependency on income from oil palm. For households under the resource-providing contract, income from other sources is largely

unchanged, so that the large increase in household income is mainly attributable to gains in oil palm profits. Both contracts substantially reduce the variability of production costs and all income sources.

Overall, our findings underline that contract characteristics matter and should not be ignored when designing contract farming policies and when estimating resulting effects. In this setting, both types of contracts have similar effects on total household income but quite different effects on various income components, which further underlines that disaggregated analysis of different income sources is important to understand the underlying mechanisms. Follow-up research on the effects of different types of contracts will be useful to provide the knowledge required for the development of suitable contract designs.

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Appendix

Table A1: Exclusion restriction correlation test

	IV: Share of households producing oil palm commercially	IV: Village chief is a commercial oil palm farmer
Oil palm profits	-0.0759	-0.0482
Profits other cash crops	-0.0087	-0.0234
Livestock profits	-0.0029	0.0178
Income off-farm wage and self-employment	-0.1488	-0.1478
Total household income	-0.0930	-0.0965

Note: The correlations are for the control group only.

Table A2: First-stage IV regressions (reduced form)

	Marketing Contract	Resource-providing Contract
Age of the household head (in years)	-0.02*	0.06***
	(0.01)	(0.01)
Experience of the household head (in years)	0.06***	-0.07***
	(0.01)	(0.02)
Gender of the household head (dummy)	-0.10	0.09
	(0.33)	(0.34)
Number of adult household members	-0.05	0.11
	(0.10)	(0.11)
Number of children	-0.14*	0.20**
	(0.08)	(0.09)
Official position (dummy)	-0.23	0.15
	(0.28)	(0.29)
Land availability 2008 (in acres)	-0.02	0.03
	(0.02)	(0.02)
Land availability^2 2008	0.00	-0.00
	(0.00)	(0.00)
Market access (in km)	-0.00	0.05
	(0.06)	(0.08)
IV: Share of households producing oil palm commercially	4.13***	0.52
	(0.63)	(0.69)
IV: Village chief is a commercial oil palm farmer	-2.10***	3.60***
	(0.26)	(0.43)
Constant	0.07	-6.41***
	(0.64)	(0.93)
Observations	460	460
F-Statistic	67.36	83.38
Prob > F	0.0000	0.0000
Adj. R-squared	0.2756	0.3704
P-value Anderson test	0.0000	
Cragg-Donald F-statistic	45.80	

Note: Gender is a dummy variable that equals one if the household head is female. Official position is a dummy variable that equals one if any household member holds an official position in the village. Test statistics derived through the ivregress command.

Table A3: Statistical significance of the generalized residual terms (*p*-values)

	Marketing contract	Resource-providing contract
Oil palm profits	0.934	0.813
Profits other cash crops	0.608	0.287
Livestock profits	0.666	0.261
Income off-farm wage and self-employment	0.688	0.318
Total household income	0.213	0.884

Table A4: Additional descriptive statistics

		Obs.	Mean	Std. Dev.	Min	Max
Oil palm profits (in GHS)	Comparisons	106	299.37	3497.34	-14637.84	19921.33
	Marketing contract	190	812.26	2018.42	-2871.00	18620.00
	Resource-providing contract	164	2196.28	5641.92	-7048.68	44782.06
Other cash crop profits	Comparisons	106	2138.76	9301.55	-283.85	90955.13
	Marketing contract	190	1565.20	2974.23	-388.70	24786.00
	Resource-providing contract	164	1777.91	3492.92	-1113.65	27695.50
Livestock income	Comparisons	106	43.38	146.59	0.00	1000.00
	Marketing contract	190	29.39	168.34	0.00	2205.88
	Resource-providing contract	164	44.79	208.99	0.00	2378.38
Income from off-farm wage- and self-employment	Comparisons	106	1019.39	3613.58	0.00	28000.00
	Marketing contract	190	623.08	1151.75	0.00	5555.56
	Resource-providing contract	164	638.75	2167.88	0.00	22800.00
Household Income	Comparisons	106	3500.91	9505.82	-13082.82	76336.90
	Marketing contract	190	3029.92	4319.79	-2585.00	40608.60
	Resource-providing contract	164	4657.72	8316.80	-5583.03	72869.80
Income Percentages						
Oil palm profits (in GHS)	Comparisons	105	0.43	1.32	-1.78	11.39
	Marketing contract	188	0.38	0.76	-6.26	3.29
	Resource-providing contract	164	0.72	2.34	-2.19	28.99
Profits other cash crops (in GHS)	Comparisons	106	0.29	0.87	-3.73	2.78
	Marketing contract	188	0.33	0.72	-7.26	1.78
	Resource-providing contract	164	0.14	2.27	-27.99	2.27
Livestock income (in GHS)	Comparisons	106	0.01	0.09	-0.61	0.38
	Marketing contract	190	0.01	0.05	-0.07	0.38
	Resource-providing contract	164	0.01	0.06	-0.41	0.39
Income off-farm wage and self-employment (in GHS)	Comparisons	106	0.14	0.71	-6.05	1.59
	Marketing contract	190	0.31	1.20	-2.03	13.33
	Resource-providing contract	164	0.13	0.39	-3.77	1.33

Table A5: Descriptive statistics of control variables

	Mean			Difference		
	Marketing contract (MC)	Resource-providing contract (RPC)	No contract (NC)	MC-RPC	MC-NC	RPC-NC
Observations	190	164	106			
Age of the household head (in years)	53.51	57.24	50.51	***	**	***
	(0.78)	(0.93)	(1.12)			
Experience of the household head in oil palm farming (in years)	19.75	15.69	16.74	***	***	
	(0.61)	(0.75)	(0.77)			
Gender of the household head (dummy)	0.15	0.20	0.15			
	(0.03)	(0.03)	(0.04)			
Number of adult household members (above 18 years)	2.64	2.79	2.66			
	(0.10)	(0.10)	(0.12)			
Number of child household members (14 years and below)	1.49	1.88	1.73	**		
	(0.10)	(0.14)	(0.15)			
Official village position (dummy)	0.20	0.35	0.19	***		***
	(0.03)	(0.04)	(0.04)			
Land availability 2008 (in acres)	13.34	15.18	12.87			
	(0.94)	(1.30)	(1.47)			
Market access (in km)	0.86	1.12	0.12		***	***
	(0.15)	(0.14)	(0.05)			
Willingness-to-pay (in 500 GHS)	2.15	2.08	2.73		**	**
	(0.14)	(0.16)	(0.20)			
Risk preferences	3.02	2.79	2.75			
	(0.10)	(0.12)	(0.15)			

Note: Gender of the household head is a dummy variable that equals one if the household head is female. Official village position is a dummy variable that equals one if a household member has an official position in the village. GHS stands for Ghanaian Cedis, the local currency. Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table A6: OLS estimates (full results)

	Oil palm profits	Profits other cash crops	Livestock income	Income off-farm wage and self-employment	Total household income
Marketing contract	2.29***	-0.22*	-0.43**	0.27**	1.63***
	(0.22)	(0.06)	(0.07)	(0.06)	(0.05)
Resource-providing contract	3.90***	0.23	-0.42**	0.16	1.96**
	(0.07)	(0.14)	(0.06)	(0.11)	(0.25)
Age of the household head (in years)	-0.02	0.00	-0.00	-0.06***	-0.04
	(0.02)	(0.02)	(0.01)	(0.00)	(0.03)
Experience of the household head (in years)	-0.02	-0.00	0.02	-0.01	-0.04
	(0.07)	(0.03)	(0.01)	(0.02)	(0.03)
Gender of the household head (dummy)	-1.26	-1.68	0.24	-0.16	-1.41
	(0.59)	(0.72)	(0.22)	(0.84)	(1.08)
Number of adult household members	0.02	-0.14	0.03	0.28**	-0.08
	(0.14)	(0.10)	(0.05)	(0.06)	(0.05)
Number of children	-0.10	-0.35***	0.09	-0.16	-0.14
	(0.11)	(0.03)	(0.08)	(0.08)	(0.10)
Official position (dummy)	0.06	-0.23	0.74	0.29*	0.44
	(0.07)	(0.30)	(0.36)	(0.09)	(0.47)
Land availability 2008 (in acres)	-0.01	0.14*	0.03*	-0.06*	-0.00
	(0.01)	(0.03)	(0.01)	(0.02)	(0.04)
Land availability^2 2008	-0.00	-0.00	0.00	0.00**	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Market access (in km)	0.01	0.26***	0.05	0.01	0.11
	(0.06)	(0.02)	(0.05)	(0.08)	(0.14)
Constant	3.91	5.10**	0.23	6.91***	8.68**
	(1.63)	(1.15)	(0.55)	(0.33)	(1.00)
Semi Elasticities					
Marketing contract	0.95***	-0.09***	-0.18***	0.11***	0.67***
	(0.09)	(0.02)	(0.03)	(0.02)	(0.02)
Resource-providing contract	1.39***	0.08*	-0.15***	0.06	0.70***
	(0.03)	(0.05)	(0.02)	(0.04)	(0.09)
Observations	460	460	460	460	460

Note: Cluster corrected standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01

Table A7: Control function estimates (full results)

	Oil palm profits	Profits other cash crops	Livestock income	Income off-farm wage and self-employment	Total household income
Marketing contract	2.32**	-0.15	-0.40**	0.40	2.36**
	(0.26)	(0.14)	(0.08)	(0.16)	(0.41)
Resource-providing contract	4.06**	-0.01	-0.56**	0.56	1.94**
	(0.68)	(0.31)	(0.09)	(0.25)	(0.22)
Age of the household head (in years)	-0.02	0.00	-0.00	-0.06***	-0.03
	(0.01)	(0.02)	(0.01)	(0.01)	(0.03)
Experience of the household head (in years)	-0.02	-0.00	0.02	-0.01	-0.04
	(0.08)	(0.02)	(0.01)	(0.02)	(0.03)
Gender of the household head (dummy)	-1.26	-1.67	0.24	-0.16	-1.38
	(0.58)	(0.71)	(0.22)	(0.84)	(1.08)
Number of adult household members	0.02	-0.14	0.02	0.28**	-0.08
	(0.14)	(0.10)	(0.05)	(0.06)	(0.04)
Number of children	-0.10	-0.35***	0.09	-0.16	-0.15
	(0.11)	(0.03)	(0.08)	(0.08)	(0.10)
Official position (dummy)	0.05	-0.22	0.74	0.27*	0.39
	(0.05)	(0.31)	(0.35)	(0.07)	(0.45)
Land availability 2008 (in acres)	-0.01	0.14*	0.03*	-0.06*	-0.00
	(0.01)	(0.03)	(0.01)	(0.02)	(0.04)
Land availability^2 2008	-0.00	-0.00	0.00	0.00**	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Market access (in km)	0.03	0.23*	0.03	0.08	0.22
	(0.11)	(0.07)	(0.05)	(0.10)	(0.14)
Generalized residuals (MC)	-0.00	-0.02	-0.01	-0.02	-0.18
	(0.04)	(0.04)	(0.03)	(0.04)	(0.10)
Generalized residuals (RPC)	-0.05	0.07	0.04	-0.11	0.01
	(0.17)	(0.05)	(0.03)	(0.06)	(0.06)
Constant	3.86	5.10**	0.24	6.76***	8.27**
	(1.71)	(1.08)	(0.60)	(0.16)	(1.17)
Semi elasticities					
Marketing contract	0.97***	-0.06	-0.17***	0.17***	0.98***
	(0.11)	(0.19)	(0.03)	(0.0.6)	(0.17)
Resource-providing contract	1.44***	-0.00	-0.20	0.20**	0.69***
	(0.24)	(0.11)	(0.03)	(0.09)	(0.08)
Observations	460	460	460	460	460

Note: Cluster corrected standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01

Table A8: OLS estimates (including willingness-to-pay and risk preferences)

	Oil palm profits	Profits other cash crops	Livestock income	Income off-farm wage and self-employment	Total household income
Marketing contract	2.31**	-0.27**	-0.43**	0.33**	1.64***
	(0.24)	(0.06)	(0.07)	(0.03)	(0.03)
Resource-providing contract	3.95***	0.20	-0.40**	0.20	1.98**
	(0.10)	(0.14)	(0.05)	(0.16)	(0.24)
Age of the household head (in years)	-0.02	0.00	-0.00	-0.06***	-0.04
	(0.01)	(0.02)	(0.01)	(0.01)	(0.04)
Experience of the household head (in years)	-0.02	-0.01	0.02	-0.01	-0.04
	(0.07)	(0.03)	(0.01)	(0.02)	(0.02)
Gender of the household head (dummy)	-1.10	-1.60	0.31	-0.21	-1.35
	(0.63)	(0.71)	(0.28)	(0.84)	(1.05)
Number of adult household members	0.04	-0.13	0.04	0.27*	-0.07
	(0.12)	(0.11)	(0.04)	(0.07)	(0.05)
Number of children	-0.10	-0.34**	0.09	-0.17	-0.14
	(0.12)	(0.04)	(0.09)	(0.09)	(0.11)
Official position (dummy)	0.03	-0.30	0.73	0.35*	0.43
	(0.07)	(0.34)	(0.39)	(0.11)	(0.43)
Land availability 2008 (in acres)	-0.01	0.14*	0.03	-0.07*	-0.00
	(0.01)	(0.03)	(0.01)	(0.02)	(0.05)
Land availability^2 2008	-0.00	-0.00	0.00	0.00***	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Market access (in km)	0.03	0.27***	0.06	-0.00	0.12
	(0.04)	(0.03)	(0.05)	(0.07)	(0.12)
Willingness-to-pay	0.14	-0.01	0.06	0.03	0.05
	(0.12)	(0.05)	(0.06)	(0.10)	(0.07)
Risk preferences	0.14	0.20	0.07	-0.18*	0.04
	(0.24)	(0.10)	(0.11)	(0.04)	(0.13)
Constant	3.02	4.57*	-0.17	7.27***	8.40***
	(2.59)	(1.15)	(1.07)	(0.40)	(0.83)
Semi elasticities					
Marketing contract	0.96***	-0.11***	-0.18***	0.14***	0.68***
	(0.10)	(0.03)	(0.03)	(0.01)	(0.01)
Resource-providing contract	1.40***	0.07	-0.14***	0.07	0.71***
	(0.03)	(0.05)	(0.02)	(0.06)	(0.08)
Observations	460	460	460	460	460

Note: Cluster corrected standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01

Table A9: Full OLS Estimation Results (Inverse probability of treatment weighting)

	Oil palm profits	Profits other cash crops	Livestock Income	Income off-farm wage and self-employment	Total household income
Marketing Contract	2.07***	-0.45**	-0.37***	0.65*	1.31***
	(0.04)	(0.05)	(0.01)	(0.15)	(0.06)
Resource-providing Contract	3.99***	0.08*	-0.45***	0.32	1.97***
	(0.17)	(0.03)	(0.02)	(0.22)	(0.15)
Age of the household head (in years)	-0.03	0.01	-0.01	-0.08**	-0.01
	(0.02)	(0.01)	(0.01)	(0.01)	(0.07)
Experience of the household head (in years)	-0.06	0.02	0.01	-0.01	-0.06
	(0.06)	(0.03)	(0.01)	(0.01)	(0.04)
Gender of the household head (dummy)	-1.88	-0.97	0.10	-1.04	-1.99
	(1.00)	(0.98)	(0.10)	(0.68)	(1.10)
Number of adult household members	0.15	-0.10	0.18*	0.25**	-0.07
	(0.14)	(0.05)	(0.06)	(0.05)	(0.17)
Number of children	-0.23	-0.33**	0.05	-0.33*	-0.20
	(0.12)	(0.06)	(0.06)	(0.10)	(0.09)
Official position (dummy)	-0.54	0.03	1.13	0.72	0.17
	(0.28)	(0.51)	(0.53)	(0.40)	(0.36)
Land availability 2008 (in acres)	0.05	0.10	0.01	-0.10***	-0.01
	(0.04)	(0.06)	(0.01)	(0.01)	(0.04)
Land availability^2 2008	-0.00	-0.00	0.00*	0.00**	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Market access (in km)	-0.12*	0.27***	0.04	-0.08	0.08
	(0.03)	(0.01)	(0.03)	(0.16)	(0.12)
Constant	4.52*	4.98**	0.28	8.56**	7.94
	(1.35)	(0.86)	(0.57)	(0.91)	(2.95)
Semi Elasticities					
Marketing Contract	0.86***	-0.18***	-0.15***	0.27***	0.54***
	(0.02)	(0.02)	(0.00)	(0.06)	(0.02)
Resource-providing Contract	1.65***	0.03***	-0.19***	0.13	0.81***
	(0.07)	(0.01)	(0.01)	(0.09)	(0.06)
Observations	460	460	460	460	460

Note: Cluster corrected standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01