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Participation Decision and Impact of Contract Farming System on Rice Farms in Myanmar

Aye Moe San
Lecturer, Department of Agricultural Economics, Yezin Agricultural University
E-mail: dr.ayemoesan@yau.edu.mm

ABSTRACT

Myanmar, once known as not only "rice basket of Asia" but also "the world's largest rice exporter" stood as 7th largest global rice producer in 2014. Successive governments attempted priority on rice sector in any agricultural policies, thus, rice exists as a strategic sector due to wide spread utilization, contribution to country's GDP, creating income and employment generation in Myanmar. Rice contract farming system was introduced by Rice Specialization Companies in Myanmar at the end of 2008, by encouraging private sector participation for rice sector development. Some companies practice written contracts with individual farmers while others apply written or verbal contracts with group of farmers. Under the rice contract farming system, rice farmers can get seeds, fertilizers, credit and technical support from contracted companies as well as they have stable market access as compared to the traditional system. This study attempts to evaluate the smallholder households' decision to participate into the contract scheme and the contribution of contract participation on smallholders' rice farm performance in Myanmar, specifically in Danuphyu Township, Ayeyarwaddy Region and Pyay Township, Bago (West) Region. It uses full information maximum likelihood estimation of endogenous switching regression (FIML ESR) model on a total of 403 smallholders (220 contract and 183 non-contract smallholders). The empirical results show that age and education level of household heads, frequencies of production shocks experienced during the last five years, participation into farmer organizations, and frequently contact with extension services are influencing the decision of smallholders to participate in the contract farming scheme. Probability of smallholders' contract participation also differs between two study townships. Overall findings indicate that contract farming has positive and significant impacts on gross margin of paddy production. Contract scheme with individual smallholders along with provision of seeds, fertilizers and credit showed more effective ways to improve smallholder livelihoods rather than group contract arrangement with only fertilizers provision.

Keywords: Rice, contract farming, smallholders, Myanmar, Endogenous switching regression

INTRODUCTION

Myanmar was known as not only "rice basket of Asia" but also "the world's largest rice exporter" during 1940s. Myanmar's paddy production stood as 7th rank among top ten global paddy producing countries and 3rd largest rice exporter in Southeast Asia in 2014 (FAO, 2014). During 2013-2014, paddy accounted 35% of total crop sown areas, 40% of total gross agricultural output and contributed 13% of gross domestic product (GDP) in Myanmar. Labor engagement rate is also the highest in the rice industry as compared to other crops and approximately three-fourths of farm household income is derived from rice farming and related activities, especially in the main rice producing areas of Ayeyarwaddy, Bago and Sagain Regions (World Bank, 2014). Paddy production has been increasing more than 50% up to 2013-2014, which was two and half decades after market oriented economy was adopted, thus country has sufficient volume for growing population and considerable surplus to export. Share of rice export value in agricultural export value and total export value were also increased after multi parties' government era since 2011 (CSO, 2012).

"Rice" as being the staple food as well as a source of employment opportunities and export earnings in national economy, remains as a strategic crop for socioeconomic development of Myanmar. Government therefore reforms and implements various agricultural policies prioritizing the rice sector development which includes encouraging private sector participation. Poor paddy yield, usage of poor quality seeds, mixing large number of varieties which dilutes the quality of pre-processing paddy, limited post-harvest infrastructures, antiquated mills, high production and marketing costs, ambiguous and arbitrary trade policy measures, and high port and export procedure costs are major bottlenecks to smallholder dominated rice farming and rice sector development in Myanmar (Fujii and Satyanarayan, 2015).

Private rice specialization companies (RSCs) introduced the contract farming system along Myanmar's rice value chain since 2008 monsoon season especially in major rice growing areas of the country. Contract farming system has been considered as one of the potential business models to link smallholders to world export markets along the stable supply chain as well as an institutional solution in the provision of inputs, finance and technical assistance to resource poor smallholders. Rice contract farming scheme in Myanmar is still a new phenomenon and there are limitations in studies and growing literatures. Therefore, an empirical research is essentially and statistically needed to get a better understanding about how this system has been empowered in smallholder rice farming and rice sector development. This study attempts to answer: "which factors are determing the probability of smallholders' participation in rice contract farming? How does rice contract farming influence on rice farm performance of smallholders?" in Myanmar.

Rice contract farming system with Rice Specialization Companies (RSCs)

Gold Delta RSC, Danuphyu township in Ayeyarwaddy region and Khittayar Hinthar RSC, Pyay township in Bago (West) region are purposively selected in this study due to their actively operating contract farming system, wide area of paddy production and large numbers of smallholders under contracts. Basic information and detail specification of contract farming schemes by selected RSCs are illustrated in Table 1.

Gold Delta RSC practices informal contract model, and is working seasonal written contract with individual smallholders and providing certified seeds along with farm inputs including seasonal credit, and product market. Gold RSC has two types of contract farmers who are seed producers and grain producers. There is more input provision, higher purchasing paddy price and strictly control measures in line with following good agricultural practices for contract farmers (seed producers), as compared to provision, purchased price and controls over cultural practices for contract farmers (grain producers). Khittayar Hinthar RSC also uses seasonal written contract with group of farmers by providing fertilizers and output market. It practices intermediary contract model which includes formally contracting with village head/farmer leader who informally contracts with a number of farmers.

Table 1. Rice contract farming schemes in study areas

A. Contract company		
Company name	Khittayar Hinthar RSC	Gold Delta RSC
Location	Pyay township, Bago (West) region	Danuphyu township, Ayeyarwaddy region
Established year	2009	2009
CF target market	Domestic, International	Domestic, International
CF business model	Intermediary model	Informal model
CF product	Rice seed and grain	Rice seed and grain

Farmer selection criteria	• Own or has proper paddy land not less than 0.40 ha and not more than 4.05 ha • Hard working, resource endowment, trustworthy and based on recommendation by village leaders/farmer-to farmer • Able and willing to adopt the guidance/techniques of contract company in rice farming • Loyalty to the CF scheme	• Own or has proper paddy land not less than 0.40 ha and not more than 4.05 ha • Hard working, resource endowment, trustworthy and based on recommendation by village leaders/farmer-to farmer • Able and willing to adopt the guidance/techniques of contract company in rice farming • Loyalty to the CF scheme
B. Contract specifications		
Type of contract	Written contract with group of farmers	Written contract with individual farmers
Contract duration	7 month seasonal contract (June to December)	8 month seasonal contract (June to January)
Embedded items and services provided	- Fertilizer (Credit in kind): • Urea 200kg for farmer who has < 1.93 ha paddy land • Urea 50kg and compound fertilizer 25kg per 0.40 ha for farmer who has 1.93<paddy land>4.05 ha - Knowledge transfer for improving yield and farm management	✓ For contract farmers (grain) - Rice varieties: Sinthwelatt and Hmawbi 2 -Seed: 62.7 kg per 0.40 ha -Credit: 100,000 Kyats/0.40ha including seed cost ✓ For contract farmers (Seed) - Rice varieties: Sinthwelatt and Hmawbi 2 -Seed: 31.35 kg per 0.40 ha for Sinthwelatt variey, 20.9 kg per 0.40 ha for Hmawbi 2 variety -Credit: 150,000 Kyats/0.40 ha including seed cost only -Fertilizers for 0.40 ha (credit in kind): Urea: 50 kg, Tsuper: 25 kg, Potash: 12 kg - Knowledge transfer for improving yield and farm management - Access to company's facilities (eg. access to machinery facilities for land preparation, harvesting)
Production practices	No strict control over land preparation and planting method.	No strict control over land preparation and planting method for contract grain producers. For seed contract farmers, there is strict control over usage of seed, fertilizers, land preparation and transplanting methods according to good agricultural practices.
Product quality criteria	Moisture content 15 % and good in quality	Moisture content 15 %, and good in quality
Pricing mechanism	Current market price at delivery time	For contract farmers (grain), At Danuphyu 100 ton mill, - 4,000 Kyats/46 lb (4.05 US$/46lb) - 4,347Kyats/50 lb (4.40 US$/50lb) - 4,521 Kyats/52 lb (4.58

		US$/52lb) At Sankin/Sakagyi villages'collection point, - 3,900 Kyats/46 lb (3.95 US$/46lb) - 4,247 Kyats/50 lb (4.30 US$/50lb) - 4,421 Kyats/52 lb (4.48 US$/52lb) (P.S. Company will buy with current market price if the market price at delivery time is higher than the contract price) For contract farmers (seed) At Danuphyu 100 ton mill, - 5,500 Kyats/46 lb (5.57 US$/46lb) Negotiation price depends on the seed quality
Delivery of product	Only paddy produce will be accepted rather than cash repayment for fertilizers, and amount of product to be delivered is equal to the cost of supported fertilizer. The deadline of product delivery is 31 December.	Minimum (50 bsk/ac) of paddy has to sold to RSC. The value of credit in kind and cash has to be deducted from the value of product sold. The deadline of product delivery is 31 January.
Regulations of contract	Nil	Both parties have to follow all specifications of contract. If one side breaks, the action will be taken according to the current laws and regulations.

Note: Exchange rate during the survey period (June to December, 2014) is 1 US$ = 987.82 Kyat according to central bank of Myanmar.
Source: Author's compilation based on interviews of RSCs and their related documents.

ANALYTICAL FRAMEWORK

A total of 220 contract smallholders and 183 independent smallholders from total 9 villages of two selected townships are randomly interviewed with well-structured questionnaires focusing on socioeconomic characteristics of households and detailed data on monsoon paddy farming activities during 2014-2015. Participation into contracts is not only self-selection of smallholders but also non-random selection by RSCs. Thus, participation decision could be influenced by the observed (farm and household characteristics), and unobserved factors (motivation and management skills) of smallholders. Full information maximum likelihood estimation of endogenous switching regression model (FIML ESR) is used by accounting both observed and unobserved selection bias (Lokshin and Sajaia, 2004). It calculates two separate outcome equations for contract and non-contract smallholders simultaneously along with contract selection equation.

Contract selection: $I_i = 1$ if $Z_i \alpha + \varepsilon_i > 0$, $I_i = 0$ if $Z_i \alpha + \varepsilon_i \leq 0$ (1)

Outcome functions: Regime 1: $Y_{1i} = \beta_1 X_{1i} + \mu_{1i}$ if $I_i = 1$ (2)

Regime 2: $Y_{2i} = \beta_2 X_{2i} + \mu_{2i}$ if $I_i = 0$ (3)

where, I_i equals 1 for contract smallholders, and 0 for independent smallholders; Y_{1i} and Y_{2i} are outcomes (i.e., gross margin per hectare of monsoon paddy here) for contract and non-contract smallholders; Z_i, X_{1i} and X_{2i} are vectors of factors (socioeconomics and institutional characteristics); α, β_1 and β_2 are the parameters to be estimated; and ε_i, μ_{1i} and μ_{2i} are the error terms. Under assumption of trivariate normal distribution of the error terms with mean zero and covariance matrix,

$$\Omega = \operatorname{cov}(\varepsilon_i, \mu_{1i}, \mu_{2i}) = \begin{pmatrix} \sigma_\varepsilon^2 & \sigma_{\mu 1 \varepsilon} & \sigma_{\mu 2 \varepsilon} \\ \sigma_{\mu 1 \varepsilon} & \sigma_{\mu 1}^2 & \sigma_{\mu 1 \mu 2} \\ \sigma_{\mu 2 \varepsilon} & \Sigma_{\mu 1 \mu 2} & \sigma_{\mu 2}^2 \end{pmatrix} \quad (4)$$

where, Ω = variance – covariance matrix to control for selection bias, σ_ε^2, $\sigma_{\mu 1}^2$ and $\sigma_{\mu 2}^2$ represent variances of the error terms in the equations (1, 2 and 3) respectively. $\sigma_{\mu 1\varepsilon}$ and $\sigma_{\mu 2\varepsilon}$ represent the covariance between μ_{1i} and ε_i, and μ_{2i} and ε_i respectively. The covariance between μ_{1i} and $\mu_{2i,}$ $(\sigma_{\mu 1\,\mu 2})$ is unobservable as a smallholder cannot simultaneously be a contract and non-contract smallholder, thus $\sigma_{\mu 1\,\mu 2}$ cannot be estimated (Maddala, 1986). As the coefficient α is only estimable up to a scale factor in the selection equation (1), the variance of σ_ε^2 is assumed to be 1. According to Fuglie and Bosch (1995), under given assumptions of three error terms structure, the conditional expectation of the truncated error terms $[\mu_{1i} \mid I_i = 1]$ and $[\mu_{2i} \mid I_i = 0]$ can be expressed as:

$$E[\mu_{1i} \mid I_i = 1] = E[\mu_{1i} \mid \varepsilon_i > -Z_i\alpha] = \sigma_{\mu 1\varepsilon}\frac{\phi(Zi\,\alpha)}{\Phi(Zi\,\alpha)}\left(= \sigma_{\mu 1\varepsilon}\lambda_{i1}\right) \quad (5)$$

$$E[\mu_{2i} \mid I_i = 0] = E[\mu_{12i} \mid \varepsilon_i \leq -Z_i\alpha] = \sigma_{\mu 2\varepsilon}\frac{-\phi(Zi\,\alpha)}{1-\Phi(Zi\,\alpha)}\left(= \sigma_{\mu 2\varepsilon}\lambda_{i2}\right) \quad (6)$$

where , λ_{i1} and λ_{i2} are the Inverse Mills Ratios (IMR) computed from the selection equation (1), and $\phi(.)$ and $\Phi(.)$ are the probability density function and cumulative distributive function of standard normal distribution, respectively. Following Maddala (1986), a probit model can be applied to generate λ_{i1} and λ_{i2} from selection equation (1), which can be treated as missing variables in equation (2) and (3). In the second stage, the selection bias terms λ_{i1} and λ_{i2} are added to the outcome equations which can then be consistently estimated by OLS, to correct for selection bias. This can be estimated using a two-stage estimation procedure of endogenous switching regression. Therefore, equations (2) and (3) could be specified as:

$$Y_{1i} = \beta_1 X_{1i} + \sigma_{\mu 1\varepsilon}\lambda_{i1} + \zeta_{1i} \quad \text{if } I_i = 1 \quad (7)$$

$$Y_{2i} = \beta_2 X_{2i} + \sigma_{\mu 2\varepsilon}\lambda_{i2} + \zeta_{2i} \quad \text{if } I_i = 0 \quad (8)$$

where, Y_{1i} , Y_{2i}, β_1, and β_2 are as earlier defined, λ_{i1} and λ_{i2} control for bias associated with sample selection problem, especially when smallholder within and outside contract may be different from average smallholder with characteristics X_i and Z due to unobserved factors. The coefficients of λ_{i1} and λ_{i2} are estimates of the covariance terms $\sigma_{\mu 1\varepsilon}$ and $\sigma_{\mu 2\varepsilon}$, respectively. If these coefficients are non-zero ($\sigma_{\mu 1\varepsilon} \neq \sigma_{\mu 2\varepsilon} \neq 0$), there are unobserved factors associated with selection bias, it is likely the correlation between the error terms of outcome equations and the selection equation giving the case of endogenous switching. In this case, when $\sigma_{\mu 1\varepsilon} = \sigma_{\mu 2\varepsilon} = 0$, there exist exogenous switching regression. Typically, this is tested by ρ_1, the correlation coefficient between ε_i and μ_{1i} and and ρ_2, the correlation coefficient between ε_i and μ_{2i}:

$\rho_1 = \left(\frac{\sigma_{\mu 1}\,\varepsilon}{\sigma_{\mu 1}\,\sigma_\varepsilon}\right)$ and $\rho_2 = \left(\frac{\sigma_{\mu 2}\,\varepsilon}{\sigma_{\mu 2}\,\sigma_\varepsilon}\right)$ respectively.

The residuals ζ_{1i} and ζ_{2i} in the above equations (7) and (8) cannot be used to determine the variances of the second-stage estimates (Fuglie and Bosch, 1995). Models with self-selection or endogenous switching can be estimated one equation at once either by two-step least square or maximum likelihood estimation. However, both of these estimation methods are inefficient and theses approaches require the potentially cumbersome adjustments to derive the consistent standard errors. Lokshin and Sajaia (2004) introduced the "movestay" command in the statistical software STATA, which implements the full information maximum likelihood (FIML) to simultaneously estimate binary selection and continuous outcome parts of the model in order to yield the consistent standard errors. Therefore, this study applies FIML endogenous switching regression model which estimates the selection and outcome equations simultaneously and to yield the consistent standard errors. The model gives the test for joint independence of the two equations, if $\sigma_{\mu 1\varepsilon}$ and $\sigma_{\mu 2\varepsilon}$ in equations (7) and (8) show non-zero and statistically significant, there is endogenous switching, otherwise, there is exogenous switching. In addition, a better identification requires an exclusion restriction because the FIML ESR model is identified through the non-linearities of λ_{i1} and λ_{i2}. Verbeek (2012) said that the Z variables in selection equation (1) are expected to contain at least one variable not in X variables of outcome equations (2) and (3). This variable directly affects smallholders' participation decisions but does not directly affect outcome interest (gross margin) of the smallholder households. Access to extension services is here considered as the instrumental variable for identification of FIML ESR model and a simple falsification test is applied to valid the selection instrument.

Given the trivariate normal distributions of error terms, FIML ESR model is written as follow:

$$\text{Ln } Y_i = \sum_{i=1}^{n}\{I_i w_i [\text{Ln}(\phi(\eta_{1i}) + \text{Ln}(\Phi(\frac{\mu_{1i}}{\sigma_{\mu 1}})/\sigma_{\mu 1}) + (1 - I_i) w_i [\text{Ln}(1 - \phi(\eta_{2i})) + \text{Ln}(\Phi(\frac{\mu_{2i}}{\sigma_{\mu 2}})/\sigma_{\mu 2})]\} \quad (9)$$

where, w_i = an optional weight for smallholders i (i=1, 2, 3,…,n),

ϕ and Φ = the probability density and cumulative distributive functions of standard normal distribution,

$\eta_{ji} = \frac{(Z_i \alpha + \rho_j \mu_{ji}/\sigma_{\mu j})}{\sqrt{1-\rho_j^2}}$ (j= CF, NCF)

where ρ_j represent the correlation coefficients between ε_i and μ_{1i} (ρ_{CF}) and, between ε_i and μ_{2i} (ρ_{NCF}), respectively. To ensure that the estimated ρ_{CF} and ρ_{NCF} are bounded between -1 and 1 and estimated $\sigma_{\mu 1}$ and $\sigma_{\mu 2}$ are always positive, the maximum likelihood directly estimates $\ln\sigma_{CF}$, $\ln\sigma_{NCF}$ and *atanh* ρ_j: where $atanh\,\rho_j = \frac{1}{2}\ln\left(\frac{1+\rho_j}{1-\rho_j}\right)$.

The estimated correlation coefficients, ρ_{CF} and ρ_{NCF} of ESR model provide the interesting insights of the sample smallholders in choosing the contract scheme. When $\rho_{CF}>0$, implies "positive selection" into choosing contract, smallholders that actually chose contract scheme, have above average gross margin under contract. If non-contract smallholders have, in fact, chosen to join the contract, their performance would be worse than actual contract smallholders. If $\rho_{CF}<0$, "negative selection" into choosing the contract, or actual contract smallholders have below average performance under contract. In this case, if the non-contract smallholders have, in fact, chosen to join the contract, their performance would be above that of the contract smallholders. Conversely, $\rho_{NCF}>0$ implies "negative selection" into not choosing the contract for non-contract smallholders. In other words, the non-contract smallholders have below average performance, and if the contract smallholders have, in fact, chosen not to contract, their performance would be above that of the non-contract smallholders. If $\rho_{NCF}<0$, "positive selection" into not choosing the contract for non-contract smallholders, or smallholders who actually choose not to enter the contract have above average performance. In the case, if the contract smallholders have, in fact, chosen to not to engage the contract, their performance would be worse than that of the non-contract smallholders. After parameters are estimated in ESR model, following Di Falco *et al*. (2011), the conditional expectations, average treatment effects and heterogeneity effects of gross margin of monsoon paddy in the observed and hypothetical scenarios are calculated as presented in Table 2:

The conditional expectations of outcome interests of:

Contract smallholders with contract (observed in the sample),

$$Y_{C1\text{-}1i} = E(Y_{1i} | I_i = 1, X_{1i}) = X_{1i}\beta_1 + \sigma_{\mu 1\varepsilon}\rho_1\lambda_{i1} \quad (10a)$$

Non-contract smallholders without contract (observed in the sample),

$$Y_{C2\text{-}2i} = E(Y_{2i} | I_i = 0, X_{2i}) = X_{2i}\beta_2 + \sigma_{\mu 2\varepsilon}\rho_2\lambda_{i2} \quad (10b)$$

Contract smallholders without contract (counterfactual),

$$Y_{C2\text{-}1i} = E(Y_{2i} | I_i = 1, X_{1i}) = X_{1i}\beta_2 + \sigma_{\mu 2\varepsilon}\rho_2\lambda_{i1}$$

(10c)

Non-contract smallholders with contract (counterfactual),

$$Y_{C1\text{-}2i} = E(Y_{1i} | I_i = 0, X_{2i}) = X_{2i}\beta_1 + \sigma_{\mu 1\varepsilon}\rho_1\lambda_{i2} \quad (10d)$$

Table 2. Treatment and heterogeneity effects

Sample	Decision stage		Treatment effect
	To participate	Not to participate	
Contract smallholders	(10a)	(10c)	ATT=(10a)-(10c)
Non-contract smallholders	(10d)	(10b)	ATU=(10d)-(10b)
Heterogeneity effects	BH1	BH2	TH

Note: (10a) and (10b) represent observed expected gross margin/hectare of monsoon paddy; (10c) and (10d) represent counterfactual expected gross margin/hectare of monsoon paddy of contract and non-contract smallholders; $I_i = 1$ if smallholder household participates into contract scheme, $I_i = 0$ if smallholder household did not participate into contract scheme; Y_{1i} = gross

margin/hectare if the smallholder households participated, Y_{2i} = gross margin/hectare if the smallholder households did not participate; ATT = the average treatment effects of the treatment (i.e., participation into contract) on the treated (i.e., contract smallholders), ATU = the average treatment effects of the treatment (i.e., participation into contract) on the untreated (i.e., non-contract smallholders); BH_i = the effects of base heterogeneity for contract smallholders (i= 1) and non-contract smallholders (i=2); TH = (ATT –ATU) = the transitional heterogeneity.

RESULTS AND DISCUSSIONS

Household characteristics

Selected household characteristics of sample smallholders are characterized after categorizing them into contract and non-contract groups, as in Table 3. In both regions, sample contract smallholder household heads are younger and less rice farming experience in comparison with non-contract smallholder heads. The sample contract smallholder household heads have above secondary level education while non-contract smallholders attended up to secondary level education. Majority of sample households are male headed households. Average family sizes of sample households in Pyay were lower as compared to those in Danuphyu. Almost half of family members of sample households in both regions contribute in agricultural activities. The average farm sizes of sample farmers in Pyay and Danuphyu are nearly equivalent with the country's average land holding size which is 2.65 ha per rural household.

Table 3. Household characteristics of sample smallholder households

Item	Pyay		Danuphyu	
	Contract	Non-contract	Contract	Non-contract
Age of HH head (year)	44.70	58.47	46.21	57.08
Rice farming experiences (year)	23.41	37.68	20.69	37.30
Education of HH head (year)	8.10	6.07	9.96	5.91
Gender (%)				
Male	83.51	88.17	98.37	100.00
Female	16.49	11.83	1.63	0.00
Family size (No.)	4.03	4.06	4.76	4.60
Agri-labor (No.)	1.70	1.81	1.76	1.81
Farm size (ha)	2.65	2.40	2.97	2.61

Farm characteristics

As shown in Table 4, contract smallholders have more cultivated area, yield per unit area and price of monsoon paddy in comparison with non-contract smallholders in both regions. Urea and compound fertilizers are used more by sample smallholders in Pyay while T super and potash fertilizers are used more by sample smallholders in Danuphyu as compared to their counterparts. Seed rate used by sample contract smallholders from Danuphyu look less than other smallholders. Family labors are not enough and sample smallholder households hire labors for their monsoon paddy production. Gross return of sample contract smallholders are higher than that of non-contract smallholders because of higher paddy yield per hectare and price received although they incur more total production costs. Therefore, sample contract smallholders get more profits in monsoon paddy production as compared to non-contract smallholders, as illustrated in Table 5.

Table 4. Farm characteristics of sample smallholder households for monsoon paddy production

Item	Pyay		Danuphyu	
	Contract	Non-contract	Contract	Non-contract
Cultivated area of monsoon paddy (ha)	2.63	2.40	2.91	2.60
Gross paddy yield (ton/ha)	3.93	3.61	4.09	3.48
Effective paddy yield (ton/ha)	3.41	3.15	3.72	2.84
Marketing charges ('000Ks/ton)	4.95	1.77	4.34	0.17

Effective paddy price ('000Ks/ton)	208.97	201.86	212.37	203.11
Seed rate (Kg/ha)	147.68	133.74	116.88	136.51
Urea (Kg/ha)	104.65	95.34	111.25	87.95
T super (Kg/ha)	3.81	5.97	51.70	49.90
Potash (Kg/ha)	-	-	7.78	1.37
Compound (Kg/ha)	87.21	70.11	29.36	43.33
Organic manure (Cart/ha)	7.41	7.41	7.41	7.41
Pesticide and Herbicide (Litter/ha)	1.72	1.68	1.44	1.81
Fuel (Gallon/ha)	7.41	7.41	7.41	7.41
Family labor (md/ha)	28.35	31.69	35.80	36.10
Hired labor (md/ha)	81.03	84.98	68.07	57.99

Table 5. Cost and return of monsoon paddy production

Benefit and Cost ('000Ks/ha)	Pyay		Danuphyu	
	Contract	Non-contract	Contract	Non-contract
Gross Benefit	712.27	636.85	790.89	577.56
Total material input cost (Cash)	132.09	110.27	143.22	123.03
Total material input cost (Opportunity)	63.70	71.34	52.11	66.73
Total family labor cost	53.78	57.92	69.38	65.75
Total hired labor cost	156.91	155.03	165.88	137.81
Total interest on cash cost	1.30	1.19	1.39	1.17
Total variable cost	407.78	395.75	431.98	394.50
Total variable cash cost	290.30	266.49	310.49	262.02
Gross Margin or Profit	304.49	241.10	358.91	183.06
Benefit-Cost ratio	1.75	1.61	1.83	1.46

Description of variables used in endogenous switching regression model

As presented in Table 6, the mean difference of gross margin of monsoon paddy of contract and non-contract smallholders is about 119,913 Ks/hectare and significant at 1% significance level. It implies contract smallholders earn more profit than their non-contract counterparts. Contract smallholder household heads are younger, more educated and richer in comparison with non-contract household heads, which are all significant at 1% level of significance. Contract smallholders have significantly larger farm size but their family members who worked in agricultural activities are lesser as compared to non-contract smallholders. Paddy price is also significantly indicating that contract smallholders gets 12,020 Ks/kg more than non-contract smallholder counterparts. There are no significant differences in cost of seed, pesticides, herbicides and fuel between two groups of smallholders, however, significant higher fertilizer cost is spent by contract smallholders than non-contract ones. Significant more hired labor cost is paid by contract smallholders while non-contract smallholders pay significant higher family labor cost than their counterparts. During the past half of the decade of monsoon paddy production, climatic attacks were significantly experienced by non-contract smallholders more than contract smallholders. Both smallholder groups faced more or less similar production shocks such as yield loss, pest and disease damages and low quality of paddy during the last 5 years of monsoon paddy production. There is no significant difference between numbers of non-farm income jobs between two groups of smallholders. Access to extension services and participation in local farmer based organization by contract smallholders are significantly higher in comparison with non-contract group. Although there is no significant difference for market distance between two farmer groups, contract smallholders are located close to output markets compared to non-contract smallholders, indicating that more opportunity to get contact with RSCs for initial adoption.

Table 6. Description of variables used in endogenous switching regression model

Variables	Description	Mean (SD)		t statistics
		Contract (N=220)	Non-contract (N=183)	
Selection (treatment) variable				
Contract farming monsoon paddy	1= if household participates in contract farming scheme in 2014 production season, 0= otherwise			
Outcome variables:				
Gross margin	Gross margin per hectare of monsoon paddy (Ks/ha)	393,389 (115,945)	273,476 (103,614)	10.84***
Explanatory variables				
Age	Age of household head (year)	45.55(9.10)	57.79 (6.94)	15.31***
Gender	1= if HH head is male 0= if HH head is female	0.92 (0.27)	0.94(0.24)	0.85
Education	Completed schooling years of HH head (year)	9.14 (3.01)	6.00 (2.14)	12.19***
Family size	Total family member in HH (No.)	4.44 (0.10)	4.33 (0.10)	0.78
Agri-labor	Share of agricultural labor in HH (%)	41.03(15.28)	43.89 (15.67)	1.84*
Farm size	Total land holding size of HH (ha)	2.84 (0.07)	2.50 (0.06)	3.52***
Paddy price	Sold price of monsoon paddy (Ks/Kg)	215.48(21.03)	203.46 (19.41)	5.96***
Asset value	Value of all assets by HH (000Ks)	15,878 (8,441)	12,312 (4,715)	5.09***
Seed cost	Cost of paddy seeds (000Ks/ha)	40.59 (12.59)	41.06 (7.74)	0.46
Fertilizer cost	Cost of fertilizers (000Ks/ha)	73.75 (20.36)	63.25 (17.79)	5.52***
Pesti/Herbi & Fuel cost	Cost of pesticide, herbicide and fuel (000Ks/ha)	47.85 (13.83)	48.32 (1.59)	0.36
Family labor cost	Costs of total family labors (000Ks/ha)	66.15(22.68)	72.07 (24.19)	2.51**
Hired labor cost	Costs of total hired labors (000Ks/ha)	166.95 (48.62)	150.12 (44.49)	3.63***
Demo shock	HH experienced from illness/dead/ birth in the past 5 years (No.)	0.75 (0.88)	0.76 (0.89)	0.06
Climate shock	HH experienced from drought/flood in monsoon paddy production in the past 5 years (No.)	0.92 (1.07)	1.11 (1.03)	1.83*
Production shock	HH experienced yield loss, pest and disease damage, low product quality in the past 5 years (No.)	1.80 (0.85)	1.78 (0.75)	0.18
Nonfarm source	Nonfarm income activities of HH(No.)	0.60 (0.58)	0.56 (0.55)	0.84
Extension	1= if HH got extension services, 0= otherwise	0.99 (0.10)	0.82 (0.39)	5.86***
Farm organization	1= if HH participate in any local farmer based organization, 0= otherwise	0.78 (0.42)	0.03 (0.18)	23.97***
Market distance	Distance from farm to selling points (miles)	8.68 (4.95)	9.33 (5.08)	1.29
Region	1= Pyay, 0= Danuphyu	0.44 (0.50)	0.51 (0.50)	1.35

Participation into contract system and its impacts on monsoon paddy profit per hectare

The estimation results to assess the impact of contract participation on gross margin (profit) of monsoon paddy per hectare, as in Table 7, provide the driving forces that motivate the smallholder farm households to participate into contract system and the estimates of outcome regression equations for contract and non-contract smallholders. The Wald χ^2 test statistics indicates that the selected covariates provide good estimates determinants to apply the model and they are jointly and statistically significant.

Determinants of participation into contract farming system

As shown in the first column of Table 7, the dependent variable for selection equation is binary, showing the value 1 if the smallholder households engage with Rice Specialization Companies (RSCs) under contract in 2014 monsoon paddy production activities and value 0 (zero) otherwise. The results show that the decision to participate into contract system is influenced by a number of farm and household characteristics, different shock experiences in paddy production, and other supported services. Sample smallholder households headed by younger and more educated household heads, who received higher market price for monsoon paddy and spent higher costs for fertilizers, participated in local farmer based organizations, got more frequently contact with extension agents, faced less production shocks during last five years in monsoon paddy production have more probability to work together with RSCs under contract system. Smallholders who lived in Pyay Township also have high probability to join contract system as compared to those lived in Danuphyu Township.

The results show that the younger and the more educated the smallholder household heads, the higher the probability of contract participation. This implies that the older household heads tend to be risk adverse and might avoid the risks by the introduction of contract farming arrangements. Education level of household head is another important determinant of participation probability into contract as shown by significant positive effect. That is consistent with the conventional economic theory on the role of literacy in improving conceptualization of information and making economically viable decisions in financial markets. These findings are corroborated by empirical results from earlier contract farming studies by Chang *et al.*, 2006; Cai *et al.*, 2008; Musara *et al*., 2011; and Mercy *et al.*, 2013. The region dummy variable expresses correlation with contract participation, likely reflecting unobservable spatial and ecological differences. Smallholder households who live in Pyay township are more likely to join contract farming arrangement as compared to smallholders from Danuphyu township.

The economic incentive such as product price could have a positive significant effect on participation decision. The policy implication by introducing contract farming system in rice sector is the facilitating and disseminating of market information, including guarantee product price and assured market, might facilitate interest to participate in contract arrangement. This result is verified by the findings of rice contract farming in Cambodia by Cai *et al*. (2008) and in Thailand by Sriboonchitta and Wiboonpoongse (2008). On the other hand, the fertilizer costs are also positively associated with contract participation decision of smallholder households. Smallholders, who are spending more expenses on chemical fertilizers in paddy production, would like to join with RSCs under contract because they could achieve supports of fertilizers as a credit in kind. Similar finding revealing positive correlation between fertilizer cost and adoption of System of Rice Intensification in Timor Leste was also confirmed by Noltze *et al.* (2013).

Production shocks such as high price of certified seeds, fertilizers, scarcity or high wage for hired labors, insufficient credit, pest and disease attacks and poor product quality which are experienced during last five years of monsoon paddy production are significant and negatively associate with the contract participation probability of smallholder households. Smallholders who faced high production shocks in past five years might have the unsecured conditions to meet the contract terms and agreements such as minimum product quantity to be sold to RSCs and the product quality standard of RSCs.

The participation into local farmer based organizations at village tract level and having frequently and regularly contacts with extension services are positive and significantly associate on the contract participation of smallholder households. The main function of local farmer based organizations is to provide season loan for monsoon paddy production as well as sharing agricultural production and market information among each other. The collective action might enable smallholders to attain better bargaining power, economies of scale and reduce transaction costs. Therefore, participation into such farmer based organizations could provide information about contract farming, which supports to high probability of contract participation of smallholders. Similar finding confirmed by Sharma (2008) is

that membership in farmers' group/association/cooperatives significantly determined participation in contract farming. Farm households who come to know contract farming system via contact with extension staffs from RSCs were more likely to make contract with RSCs, as compared to farm households who are informed by other agricultural information dissemination pathways. These results also validate with recent studies that revealed access to extension services is one of the most important factors to enhance the technical capability for better yield and increased the likelihood of smallholders' contract participation (Adam Kephas, 2011; Ogeto *et al.*, 2012; Moyo, 2014; Abdulai, 2016; Azumah *et al.*, 2016).

Table 7. FIML ESR estimates: Contract participation decision and functional relationship between smallholders' characteristics and monsoon paddy profit

Explanatory variable	Participation decision	Gross margin (profit) per hectare (ln)	
		Contract smallholders	Non-contract smallholders
Age (year)	-0.09*** (0.02)	0.01** (0.00)	0.001 (0.01)
Gender	0.20 (0.44)	0.28** (0.10)	0.22 (0.25)
Education (year)	0.16** (0.05)	0.03** (0.01)	-0.001 (0.03)
Family size (No.)	-0.17 (0.11)	-0.11*** (0.02)	-0.07 (0.05)
Agril-labor (%)	-0.01 (0.01)	-0.001 (0.00)	-0.01 (0.00)
Farm size (ha)	0.07 (0.21)	0.12** (0.04)	0.10 (0.13)
Asset value (ln)	0.54 (0.50)	0.11 (0.08)	0.04 (0.28)
Paddy price (Ks/kg)	0.01** (0.01)	0.01*** (0.00)	0.01** (0.00)
Seed cost (ln)	0.08 (0.51)	-0.34*** (0.08)	-0.25 (0.29)
Fertilizer cost (ln)	0.69** (0.36)	-0.39*** (0.08)	-0.63** (0.20)
Pesti/HerbiFuelcost (ln)	-0.63 (0.51)	-0.13 (0.10)	-0.69** (0.25)
Family labor cost (ln)	0.19 (0.23)	0.05 (0.05)	-0.27** (0.14)
Hired labor cost (ln)	0.51 (0.40)	-0.29** (0.09)	-0.36* (0.20)
Demo shock (No.)	-0.10 (0.13)	-0.05* (0.03)	-0.06 (0.07)
Climate shock (No.)	0.04 (0.14)	-0.01 (0.03)	-0.03 (0.06)
Production shock (No.)	-0.40** (0.17)	-0.01 (0.03)	-0.01(0.09)
Nonfarm source (No.)	0.28 (0.26)	0.04 (0.05)	-0.23** (0.12)
Farm organization	2.54*** (0.32)	0.04 (0.08)	0.47 (0.69)
Market distance (Mile)	0.00 (0.04)	0.01 (0.01)	0.01 (0.02)
Region	0.62* (0.34)	0.08 (0.09)	0.26 (0.16)
Extension	2.03** (0.65)		
Constant	-10.03* (5.87)	5.89***(1.09)	6.66** (3.12)
ln $\delta_{CF,}$ ln δ_{NCF}		-1.04***(0.05)	-0.31*** (0.05)
ρ_{CF} , ρ_{NCF}		0.01**(0.19)	0.04 (0.48)
Number of observations			403
Wald χ^2			235.08***
Log pseudo-likelihood			-361.46
Likelihood ratio test for independent equations $\chi 2$			7.38**

Note: *, **, and *** denotes significance at 10, 5, and 1% levels. Values in parentheses represent robust standard errors.

Factors influencing on gross margin (profit) per hectare of monsoon paddy

The estimates of two outcome equations for contract and non-contract smallholder households, as in 2nd and 3rd columns of Table 7, show that product price, fertilizer and hired labor costs significantly affect gross margins of both contract and non-contract smallholders. An increase in cost of fertilizer and hired labor creates a decline in gross margin per hectare while high product price contributes positively to the profit per hectare. Monsoon paddy profit of non-contract smallholders are more elastic in response of fertilizer and hired labor cost as compared to contract smallholders. Paddy production in Myanmar is still labor intensive farming especially in transplanting, weeding and harvesting period. Paddy yield and quality could be affected at the end if these production activities are delayed because of unavailability or insufficient usage of labor (ACDGI, 2011). Therefore, smallholder households need to allocate more

labor even the hired labor wage rate might be expensive at the peak labor requirement periods in order to protect losses in yield and quality damage.

There are differences in some coefficient estimates which determined the gross margin of monsoon paddy among contract and non-contract smallholder households. These notable differences confirmed that the switching regression framework is more appropriate than data pooling in one regression. Age, gender, education level of household heads, family size, farm size, seed costs and demo shocks faced during last five years are significantly associated with the gross margin of monsoon paddy of contract smallholders; however, the effects are insignificant among the non-contract smallholders. The facts that less family size, larger farm size, and less seed costs, less frequency experienced in demo shocks suggest that the contract smallholder households might be implementing input saving activities. Positive relationship between farm size and profit shows large farm has higher profit per hectare. The contract smallholders try to efficiently use the amount of seeds per hectare because the seed prices of recommended rice varieties by RSCs are relatively expensive, and 1 % increase in seed cost would significantly cause 34 % decline in gross margin.

A case in point is the costs for pesticide, herbicide and fuel, family labor costs and the number of non-farm income sources are significantly influenced the profit of monsoon paddy of non-contract smallholders, while these factors are insignificant in the contract regime. Regular weeding and protection of pests/diseases in monsoon paddy production are recommended by Department of Agriculture (DOA) in order to achieve high yield, but not always follow by smallholders especially independent smallholders. In addition, they used to apply only family labor for land preparation and threshing process. Chemical weed control and high use of family labor in their paddy farming significantly affect monsoon paddy profit of non-contract smallholders. At the other side, an additional source of non-farm activities could lead to reduce time for paddy farming and negatively associates with monsoon paddy profit of non-contract smallholders.

Impact of contract farming on gross margin (profit) per hectare of monsoon paddy

The significance of likelihood ratio test criterion for independence of equations, as in lower part of Table 7, shows that there is joint dependence between contract selection equation and outcome functions for contract and non-contract smallholders. The sign and significance of ρ_{CF} and ρ_{NCF} for contract and non-contract smallholders report the presence of selection bias. $\rho_{CF} > 0$ and $\rho_{NCF} > 0$ show that contract smallholders would have higher profit whether they decide to participate into contract or not. The positive and significant ρ_{CF} indicates "positive selection" bias and shows that there is self-selection among contract smallholders, and both observed and unobserved factors affect the contract participation decision and gross margin. In particular, the positive sign of ρ_{CF} indicates that the contract smallholders would have above average gross margin per hectare whether they chose to join the contract or not. They have an "absolute advantage' or they could have better farms in general. On the other side, $\rho_{NCF} > 0$ shows that non-contract smallholders have lower average gross margin whether they decide to participate into contract or not. Thus, it could say that their paddy production is not as good as that of contract smallholders. The findings of positive selection bias is similar with many other impact evaluation studies, which indicated that more productive or progressive farm households were usually the first to try new technologies or new farming systems (e.g; Fuglie and Bosch, 1995; Abdulai, 2016, Haile, 2015, Tambo, 2015).

The expected gross margins per hectare of smallholders under actual (aand b) and counterfactual simulations (c and d) are presented in Table 8. Under observed conditions, the expected monsoon paddy profits per hectare by contract smallholder households are higher than that of non-contract smallholder households for each and both regions; and these differences indicate big gap. Therefore, the simple comparison between two smallholder groups can be misleading and drive the researcher to conclude that on average contract smallholders earned more than non-contract smallholders.

The average treatment effect on treated (ATT) measures the difference between the actual average gross margin of contract smallholders and the counterfactual one what they would have earned if they do not participate into contract. The average treatment effect on untreated (ATU) indicates the difference between actual average gross margin of non-contract smallholders and the counterfactual one what they would have earned if they do participate into contract. The last column of table 8 presents the percentage changes of average treatment effects on smallholder in order to provide the realistic interpretations of the treatment effects.

Table 8. Average expected monsoon paddy profit per hectare, treatment and heterogeneity effects of contract systems

Item	Decision stage		Treatment effect	Effect[1] in %
	To participate	Not to participate		
Pyay township				
CF smallholders	(a) 5.58 (0.03)	(c) 5.27 (0.05)	ATT = 0.31***(0.06)	36.34
NCF smallholders	(d) 5.50 (0.04)	(b) 5.01 (0.04)	ATU = 0.49***(0.05)	63.23
Heterogeneity effects	BH_1=0.08 (0.05)	BH_2=0.26***(0.06)	TH = -0.18***(0.05)	
Danuphyu township				
CF smallholders	(a) 5.65 (0.04)	(c) 5.15 (0.04)	ATT = 0.50***(0.05)	64.87
NCF smallholders	(d) 5.39 (0.03)	(b) 4.79 (0.05)	ATU = 0.61**(0.06)	84.04
Heterogeneity effects	BH_1=0.25***(0.05)	BH_2=0.38***(0.06)	TH = -0.11**(0.05)	
Total (Pooled sample from both twonships)				
CF smallholders	(a) 5.62 (0.02)	(c) 5.20 (0.03)	ATT = 0.42***(0.04)	52.20
NCF smallholders	(d) 5.45 (0.03)	(b) 4.90 (0.03)	ATU = 0.55***(0.04)	73.33
Heterogeneity effects	BH_1=0.17***(0.04)	BH_2=0.30***(0.04)	TH = -0.13***(0.04)	

Note: *, **, and *** denotes significance at 10, 5, and 1% levels. Values in parentheses represent robust standard errors. [1] The percentage changes in average treatment effect was derived based on 100 (e^{TE} -1), where "e" is the exponential "e" (e = 2.718) and "TE" is the average treatment effects provided by the analysis of the log-transformed variable.

As ATT and ATU show positive and statistically significant results, indicating that working together with Rice Specialization Companies (RSCs) under contract arrangements provide significant positive impact on gross margin per hectare of smallholders in both regions. The results reveal that contract farming arrangements significantly increase gross margin per hectare 52.20% for contract smallholders and 73.33% for independent smallholders if they would join into contract system. Contract smallholders in Pyay and Danuphyu would achieve 36.34% and 64.87% less profit per hectare respectively if they do not participate in contract scheme. The impact of contract farming scheme is more important for non-contact smallholders, where they would have achieved 63.23% and 84.04% more profit for Pyay and Danuphyu townships, respectively if these independent smallholders would join to RSCs through contract system. These results reveal that participation in contract system significantly increase gross margin per hectare for all smallholders; in particular, the effects are more important for non-contract smallholders because they would have benefited more by contract participation. The contract farming system in Danuphyu township is more likely to be effective than that in Pyay township.

The base heterogeneity effects of non-contract smallholders (BH_2) show that the contract smallholders would still have statistically significant higher gross margin even without contract participation (c) than the observed gross margin of non-contract smallholders (b), in each townships and both regions. The positive and significant BH_2 indicate that there are some important sources of heterogeneity that position contact smallholders to generate more profit, which also likely influence the contract participation. These sources of heterogeneity are also important in comparing (a) and (d) in order to identify the base heterogeneity effects of contract smallholders (BH_1). Due to not significant (BH_1) value, non-contract smallholders in Pyay township could earn more or less similar gross margin as contract smallholders with actual contract condition, if they would join RSCs through contracts. (BH_1) values in Danuphyu township show positive and statistically significant base heterogeneity effects. However, non-contract smallholders in Danuphyu township, although the non-contract smallholders would have benefited when they decide to participate into contract arrangements, they could not generate significant equal gross margin like as the actual contract smallholders. The transition

heterogeneity effects (TH) in each township show negative and statistically significances, indicating the effects of contract farming on gross margin are significantly lower for contract smallholders as compared to that of non-contract smallholders, though working together with RSCs via contracts could increase all smallholders' profits.

CONCLUSIONS AND POLICY RECOMMENDATIONS

This study contributes for the essential requirement of initial assessment study of rice contract farming system at farm level as well as for growing literature on the determinants of participation in contract farming system and its potential outcome effects on economic condition of smallholder farm households in Myanmar. Household characteristics (age and education level of household head), farm characteristics (paddy price, fertilizer cost, production shocks experienced during five years ago in paddy production), institutional characteristics (farmer organizations and extension access) have positive relations on the probability of contract participation. Smallholder households who live in Pyay township have more likelihood to work together with RSC via contract system compared to smallholders of Danuphyu township.

The results show that the participations in contract farming and gross margin per hectare of monsoon paddy of sample smallholders are jointly depending. Smallholder households with better gross margin above the average level of sample households, regardless of joining to contracts, are more likely to work together with RSCs. There are some important factors that skill the actual contract smallholders have better conditions than the non-contract smallholders even if they are without contract system and these important factors could have also influenced on the decision of smallholders to participate in contract farming system. There are obviously differences in some characteristics of smallholders which are determining their paddy profit of contract and non-contract smallholder groups. Such differences make smallholders into different likelihood of participation into contract and bear different extents of participation impacts on economic livelihoods of smallholders. Participation in contract arrangements shows significant positive impacts to enhance smallholders' gross margin (profit) from growing monsoon paddy. About 73% and 52% increase monsoon paddy profits for non-contract and contract smallholders respectively would be achieved under contract schemes. Smallholders who work with Gold Delta RSC through individual contracts achieve higher positive impacts on gross margin in comparison with those who work with Khittayar Hinthar RSC through contracts with group of smallholders.

Overall results imply that the contract farming system would have broader impacts on economic conditions of smallholders if appropriate strategies could be improved in reducing production shocks in monsoon paddy production and in supporting sufficient inputs especially chemical fertilizers with reasonable prices, community relationship with farmer based organizations and very often access to extension services at farm household level. These findings would suggest policy makers, authorized executives from Myanmar Rice Federation (MRF) and RSCs in the promotion of rice contract farming system in rice value chain of Myanmar. The determining factors that influence the contract participation decision of smallholders (eg; product price and fertilizer cost, access to extension services,…) could be considered as the entry points to reorganize the existing contract arrangements as well as to promote the contract system. Informal contract farming model along with supporting farm inputs including credit shows more effective way as compared to intermediary contract model with only fertilizer provision. Comparison between two RSCs in two regions indicates that the contract system of Gold Delta RSC in Danuphyu township is more efficient than that of Khittayar Hinthar RSC in Pyay township. Therefore, rather than contracting with group of smallholders, the arrangement such as contracting with individual smallholder should be considered in order to promote the contract farming system. In addition, credit seems to appear essential capital input to resource poor smallholders and informal contract farming model including credit provision should be considered in expansion of contract farming network to other rice growing area in Myanmar.

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