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Impacts of Rice Contract Farming System on Smallholders in Myanmar

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Abstract
This study attempts to evaluate the smallholder households' decision to participate contract scheme and the contribution of contract participation on smallholders' livelihood in Myanmar. 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 last five years, participation into farmer organization, and frequently contact with extension services are influencing the decision of smallholders to participate 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 livelihood of smallholders. Contract scheme with individual smallholders along with provision of seeds, fertilizers and credit shows more effective way to improve smallholder livelihoods rather than group contract arrangement with only fertilizers provision.

Keywords: Rice, contract farming, smallholders' livelihood, Myanmar, Endogenous switching regression.

Introduction
Poor paddy yield, usages 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). "Rice", as being staple food as well as source of employment opportunities and export earnings in national economy, Myanmar government reforms and implements various agricultural policies prioritizing rice sector development along with encouraging private sector participation. Private rice specialization companies (RSCs) introduced contract farming system along Myanmar rice value chain since 2008 monsoon season especially in major rice growing areas of Myanmar. 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 contract farming influence on livelihood of smallholders?"

Analytical framework

Gold Delta RSC, Danuphyu township in Ayeyarwaddy region and Khittayar Hinthar RSC, Pyay township in Bago (West) region are purposively selected. Gold Delta RSC is working seasonal written contract with individual smallholders and providing certified seeds along with farm inputs including seasonal credit, and product market. Khittayar Hinthar RSC also use seasonal written contract with group of farmers by providing fertilizers, and output market. Total 220 contract and 183 independent smallholders from total 9 villages of two 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 annual farm and total household incomes 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 μ_{2i}, ($\sigma_{\mu 1\,\mu 2}$) is unobservable as a smallholder cannot simultaneously be a contract and non-contract smallholder (MADDALA, 1986). Given the trivariate normal distributions of error terms, FIML ESR model is written as follow:

$$\text{Ln } Y_i = \sum_{i=1}^{n}\{I_i w_i [\text{Ln}(\phi(\eta_{1i}) + \text{Ln}(\Phi(\tfrac{\mu_{1i}}{\sigma_{\mu 1}})/\sigma_{\mu 1}) + (1 - I_i) w_i [\text{Ln}(1 - \phi(\eta_{2i})) + \text{Ln}(\Phi(\tfrac{\mu_{2i}}{\sigma_{\mu 2}})/\sigma_{\mu 2})]\} \quad (5)$$

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,

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

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 $atanh\,\rho_j = \frac{1}{2}\ln\left(\frac{1+\rho_j}{1-\rho_j}\right)$.

Access to extension services is considered as the instrumental variable for identification of FIML ESR model and a simple falsification test is applied to valid the selection instrument. Finally, conditional and unconditional expectations of annual farm and total household income of smallholders in observed and counterfactual cases are calculated by applying coefficients of FIML ESR to determine the average treatment effects or true impacts and heterogeneity effects of contract farming on smallholders' livelihoods.

Results and discussions

The determinants of probability of participation in contract system are presented in second column of Table 1. The results show that the probability of contract participation increase among smallholder households with young and educated household heads, more access to extension services and participation in local farmer based organizations. Also, the participation probability decreases for households with high frequencies of production shocks during five years monsoon paddy production. Regional difference also determines participation probability, that means, smallholders in Pyay township have greater likelihood in contract participation as compared to those in Danuphyu township.

Table1: FIML ESR estimates for contract participation and realationships between smallholders' characteristics and livelihoods

Explanatory variable	Participation decision	Farm income (ln)		Household income (ln)	
		CF	Non-CF	CF	Non-CF
Age of HH head (year)	-0.08***(0.01)	-0.002(0.00)	0.001(0.00)	-0.01**(0.00)	0.001(0.00)
Gender of HH head (1= Male, 0=Female)	-0.24(0.40)	0.12(0.08)	-0.02(0.08)	0.07(0.09)	-0.17**(0.08)
Education of HH head (year)	0.14**(0.05)	0.02**(0.01)	0.01(0.01)	0.02**(0.01)	0.02(0.01)
Agril-labor share in HH (%)	-0.003(0.01)	0.004**(0.00)	0.002(0.001)	0.001(0.00)	-0.001(0.001)
Dependency ratio (%)	-0.003(0.01)	-0.002**(0.00)	0.001(0.00)	-0.003(0.00)	-0.001**(0.00)
Farm size (ha)	-0.07(0.19)	0.33***(0.03)	0.33***(0.04)	0.23***(0.03)	0.21***(0.04)
Asset value (ln)	0.67(0.48)	0.20**(0.06)	0.15*(0.09)	0.20**(0.07)	0.15(0.09)
Livestock (No.)	-0.04(0.10)	-0.02(0.02)	0.03*(0.02)	0.04**(0.02)	0.03(0.02)
Cropping intensity (%)	-0.01(0.01)	0.002**(0.00)	0.004**(0.00)	0.002** (0.00)	0.003**(0.00)
Demo shock s in past 5 years (No.)	-0.04(0.13)	-0.05**(0.02)	-0.02(0.02)	-0.02(0.03)	-0.01(0.02)
Climate shocks in past 5 years (No.)	0.04(0.13)	-0.02(0.02)	-0.02(0.02)	-0.001(0.02)	-0.004(0.02)
Production shocks in past 5 years (No.)	-0.27*(0.15)	-0.02(0.02)	-0.01(0.02)	-0.03(0.03)	-0.01(0.03)
Nonfarm income activities (No.)	0.24(0.24)	-0.03(0.04)	-0.004(0.03)	0.42***(0.05)	0.40(0.04)
Particiaption in farmorg (1= yes, 0=No)	2.37***(0.27)	-0.01(0.06)	-0.35**(0.12)	-0.10(0.08)	-0.10(0.14)
Region (1= Pyay, 0= Danuphyu)	0.76**(0.31)	-0.14**(0.06)	-0.20***(0.05)	-0.08(0.07)	-0.12**(0.05)
Extension access (1= Yes, 0= No)	1.83**(0.59)				
Constant	-1.53(4.46)	4.75***(0.62)	4.41***(0.90)	5.26***(0.70)	5.16***(0.99)
ln $\delta_{CF,}$ ln δ_{NCF}		-1.30***(0.05)	-1.53***(0.05)	-1.18***(0.05)	-1.44***(0.05)
ρ_{CF} , ρ_{NCF}		0.01**(0.23)	0.04(0.21)	0.14**(0.24)	0.08(0.23)
Wald chi-square			59.27***		53.14***
Log pseudo-likelihood			-90.66		-134.56
Likelihood ratio test for independent equations chi-square			4.04**		3.44**

Note: *, **, and *** denotes significance at 10, 5, and 1% levels.Values in parentheses represent robust standard errors.
Source: Own calculation based on parameter estimates in Stata 12.0

The results also show that there are remarkable differences in some coefficient estimates determining annual farm income among contract and non-contract smallholders (3rd and 4th columns of Table 1) and total household income between two groups (5^{th} and 6^{th} columns of Table 1). The positive and significant correlation coefficients of contract smallholders (ρ_{CF}) endorse that smallholder households with better economic conditions are more likely to work with RSCs, while non-contract smallholders have lower economic performances in comparison with contract smallholders, whether they are under or outside contracts. The results show that

both smallholder groups economically benefit by participation in contract system (Table 2). Contract smallholders would earn about 26 % more annual farm income and about 19% more total household income, and non-contract smallholders would achieve about 13% more annual farm income and 9 % more total household income, if they have switched their decision to participate in contract system. Smallholders in Danuphyu township are more benefited by contract participation than those in Pyay.

Table 2: Average expected annual farm and total household income, treatment and heterogeneity effects for smallholders

Sample	Impact of CF on annual farm income				Impact of CF on household income			
	Decision stage		Average Treatment effect	Effect in %	Decision stage		Average Treatment effect	Effect in %
	To participate	Not to participate			To participate	Not to participate		
Pyay township								
CF	(a) 7.81	(c)7.67	0.14**	15.03	(a) 8.13	(c) 7.99	0.14**	15.03
	(0.05)	(0.05)	(0.07)		(0.05)	(0.05)	(0.01)	
Non-CF	(d) 7.68	(b) 7.55	0.13*	13.88	(d) 8.09	(b) 8.02	0.07	7.25
	(0.05)	(0.05)	(0.02)		(0.05)	(0.04)	(0.01)	
Heterogeneity	0.13**	0.12**	0.01**		0.04	-0.03	0.07***	
effects	(0.07)	(0.07)	(0.03)		(0.07)	(0.06)	(0.02)	
Danuphyu township								
CF	(a) 8.18	(c)7.88	0.30***	34.99	(a) 8.51	(c) 8.33	0.19***	20.92
	(0.03)	(0.03)	(0.05)		(0.04)	(0.04)	(0.01)	
Non-CF	(d)7.90	(b)7.77	0.13**	13.88	(d) 8.29	(b) 8.18	0.11**	11.63
	(0.03)	(0.03)	(0.04)		(0.04)	(0.03)	(0.01)	
Heterogeneity	0.28***	0.11**	0.17***		0.22***	0.14**	0.08***	
effects	(0.05)	(0.05)	(0.02)		(0.05)	(0.05)	(0.01)	
Pooled sample from both townships								
CF	(a) 8.01	(c) 7.78	0.23***	25.86	(a) 8.34	(c) 8.18	0.17***	18.53
	(0.03)	(0.03)	(0.04)		(0.03)	(0.03)	(0.01)	
Non-CF	(b)7.79	(b) 7.67	0.12**	12.75	8.19	(b) 8.10	0.09**	9.42
	(0.03)	(0.03)	(0.04)		(0.03)	(0.03)	(0.01)	
Heterogeneity	0.22***	0.11**	0.11***		0.15***	0.08*	0.08***	
effects	(0.04)	(0.04)	(0.02)		(0.05)	(0.04)	(0.01)	

Note: *, **, and *** denotes significance at 10, 5, and 1% levels. Values in parentheses represent robust standard errors.
Source: Own calculation based on parameter estimates in Stata 12.0

Conclusions and policy recommendations

Rice contract farming scheme has positive and significant impacts on livelihood of smallholders. Socioeconomic and institutional characteristics are influencing smallholders' contract participation decisions. Activities of farmer organizations as well as public and private sectors' extension services should facilitate more on strategies towards adopting new practices to various farm level conditions. Social policy should be promoted for mid and long term perspective by government because the private companies are basically profit making organizations and they respond only short period of time. Contract arrangements with individual smallholders along with provision of seeds, fertilizers and credit should be considered as more effective way to improve smallholder livelihoods rather than group contract arrangements with only fertilizers provision.

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