Bangladesh Development Studies
Vol. XXXIV, December 2011, No. 4

Endogenous Matching and Contractual Choice among Rice Farmers in Bangladesh

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This paper examines the presence of potential bias arising from multiple sources of endogenous matching among the landlords, tenants and activities while choosing between crop sharing contract and fixed rent contract in the agricultural farming system. The study addresses this endogenous matching problem using data from rice farmers in rural Bangladesh. Although risk sharing explanation is found consistent with naïve estimation after controlling for possible sources of matching, it is found not to have significant influence on choosing a particular tenancy contract.

I. INTRODUCTION

The empirical research on contract choice is difficult for several reasons. Researchers very often face difficulty in finding appropriate empirical measures for risk attitudes of the contracting parties, monitoring, limited liability and other transaction costs. Most of these theoretically important variables are either not observed or only observed partially. Given this problem, the empirical exercise regresses contract choice on a range of proxies relating to the characteristics of the contracting parties and the crops. However, the data usually comes from the market that consists of heterogeneous principals and agents. Analysis very often ignores the possibility of the presence of endogenous matching between these two parties. In recent years, it is widely recognised that the empirical research should be cautious about the generality of the theoretical results and consider the matching process (Aggarwal 2007). The central message of this paper is to find out possible sources of matching between the landlord and the tenant farmers and the activities. The key assumption here is that landlords are heterogeneous with

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respect to the riskiness of their asset and the tenants with respect to their degree of risk aversion coming from the unobserved risk of agricultural production.

Ackerberg and Botticini (2002) pointed out the importance of accounting for endogenous matching between the landlord and the tenant when analysing land rental markets. In their study of the land tenure contracts in Renaissance Tuscany they found omitted variable bias. Using instruments for matching, Ackerberg and Botticini (2002) find that tenants with relatively low wealth (and hence higher degree of risk aversion) were employed to cultivate vines which has higher risk, while the less volatile cereal was contracted out to wealthier tenants (low risk averse tenants). Serfes (2005) pointed out that this positive assortive relationship between the degree of risk aversion of a tenant and the riskiness of a crop seems to be counter-intuitive, although consistent with equilibrium behaviour. Another recent empirical work on this issue is that of Aggarwal's (2007) paper. He used data from Western India where he had information on actual matched partners for ground water contracts. He used a pseudo fixed nature of data to control for the omitted variable bias. Contrary to the findings of Ackerberg and Botticini (2002), he did not find the risk sharing explanation to be significant in any of the fixed effect models. However, relatively little empirical work has been done on matching accounting for more than one trait at individual level.

The present study contributes to the literature by investigating determinants of agricultural tenancy contract, specifically controlling for all possible sources /channels of endogenous matching of the principals, the agents and the activities. In Bangladesh the major cereal crops are rice and wheat. Rice dominates the cropping pattern throughout the country as almost 90 percent of population consume rice. This analysis finds sufficient conditions for the existence of more than one sources of possible matching using data from rice farmers in rural Bangladesh. Given the vast theoretical literature that already exists on the contract choice, the study does not present any new theoretical model. The underlying theoretical model is a standard principal-agent framework. However, in the presence of risk aversion and limited liability all channels that effect the landlord, the tenant and the crop practice on the tenure status is theoretically ambiguous. Which effect prevails is ultimately an empirical question.

The reminder of the paper is organised as follows. Section II illustrates the methodology of empirical exercise and the logic behind using such approach. Section III describes sources of data and summary statistics. Section IV discusses the results of empirical exercise. Some concluding remarks are made in section V.

II. METHODOLOGY

A simple contract choice equation would be of following nature:

$$c = \beta_t t + \beta_l l + \beta_r r + \varepsilon \quad (1)$$

where c is a binary contract choice variable which is equal to one if a share contract is observed and zero if a fixed payment contract is observed. *t*, *l* and *r* are the characteristics of the tenant farmer, the landlord farmer and the crop variety which determine contract choice. β_t, β_l and β_r are the corresponding vectors of unknown coefficients. ε is assumed to be random error term that is distributed independently and identically with mean zero and constant variance. If all the characteristics of the tenant, the landlord and the crop variety is fully observed and are uncorrelated with ε, then a binary choice regression of (1) would give consistent estimates.

A fundamental problem with econometric estimation of equation (1) arises when the tenant farmer's (agent in principal-agent theory) characteristics are partially observed or may not be observed at all. For example, risk preferences of the tenant and the landlord are crucial determinants of the contract attributes, but such preferences are typically observed in the data. However, it is common in the empirical work on contractual choice to use proxies (o) for such unobserved characteristics. Following Ackerberg and Botticini (2002), the proxy equation can be written as (2) and estimate regression (3) instead

$$t = o + \varepsilon_t \quad (2)$$

$$c = \gamma_o o + \beta_l l + \beta_r r + \varepsilon_o \quad (3)$$

where $\gamma_o = \alpha_o \beta_t$ and $\varepsilon_o = \varepsilon_t \beta_t + \varepsilon$. For example, income, wealth, age, off-farm income and debt-to-asset ratio are often use as proxies for risk aversion[3].

Another problem with estimating equation (3) by means of standard method is that the coefficients become biased if the agents endogenously match with observed and unobserved activities and/or principals. If such endogenous matching exists, omitted variable bias in the coefficients arises because of the correlation between the regressors in (3) and the residuals ε_o. As, for example, the association between crop types and the agents is presented by the matching equation (4).

[3] Aggarwal (2007), Huffman and Just (2004), Allen and Lueck (1999)

$$r = \alpha_t t + \varepsilon_r \quad (4)$$

$$r = \alpha_t \alpha_o o + \alpha_t \varepsilon_t + \varepsilon_r \quad (5)$$

where equation (5) follows from (2). But (5) implies that regressors might be correlated with the residual in equation (3) and estimation by means of standard methods will yield biased estimates for such a regression (Greene 2003). Similar argument can be made if the agents are endogenously matched with certain characteristics of the principal.

To control for the potential omitted variable bias stimulated by matching, Ackerberg and Botticini (2002) argued that the preferred solution is to find suitable instrumental variables that affect the matching equation but do not affect the contract choice equation or the proxy equation. He instrumented crop choice decided by the landlord and used region dummies under the assumption that the observations came from different geographical regions with different population distributions of the tenants or the landlords. On the other hand, Aggarwal (2007) used fixed effect model to control the unobserved characteristics of trading partners that determine the matching process. Within- group estimator would be a better choice if the data set has a unique tenant-landlord configuration as a group which Aggarwal's data set had. However, the data set used in this study does not have the data on actual matched pair of the tenant and the landlord. Moreover, the initial task to test whether there is an endogenous matching between the landlords and tenant and what may be the channel to this matching is overlooked by the literature. This is generally problematic. Bellmere (2006) regressed the landlord (tenant) levels of assets per capita within the household on the tenant (landlord) characteristics for the sub-sample of cases where the contract is not signed between them. After finding out the possible channel, he followed Ackerberg and Boticcini's method and used geographical dummies as instruments.

The present analysis has been carried out looking at both possibility of matching between the agents and the principals and the agents and activities i.e. crop practice. In order to identify whether there is endogenous matching between the landlords and the tenants in the data set, the study regressed the landlord (tenant) levels of asset and social connections within a household on the tenant (landlord) characteristics. The analysis is also focused in the possible matching between cropping intensity and the agents' behaviour. Rice farmers in rural Bangladesh essentially cultivate three different types of rice namely Aus, Aman and Boro. In the case of crop practice, each farming household can be grouped as mono cropping, double cropping or triple cropping household cultivating one crop in a cropping year or twice or thrice respectively. A farmer's decision

regarding which set of crop/crops to grow in a given year is generally quite complex. In rural Bangladesh, like many other parts around the world, proper sequencing of crop across seasons is a very important decision taken by the farmers actively involved in cultivation. Output would be higher for double cropped and triple cropped crop practice but would be more expensive and effort intensive. Since the importance of both risk aversion and limited liability depends on the risk preferences of the tenant, the theory predicts that the tenants' risk attitude determines incentive cost and hence the equilibrium choice of effort and techniques. Therefore, by regressing crop practice on tenant farming household risk preferences may indicate the presence of potential matching (if any) between crop and farmers' level of risk aversion.

To solve this problem by using instrumental variable technique, one needs to be cautious in view of the fact that, ecological and environmental factors affect final output. Moreover, theoretically, these factors affect the reservation utility of an agent, which is likely to affect not only who is matched with whom but also the choice of tenancy contract. Therefore, in choosing instruments one needs to be careful about distinction from pure geographical distribution representing different markets with ecological distribution. With this in view, this paper uses rainfall variations, soil type dummies and dummies for different ecosystem as control variables in all equations. Dummies for administrative divisions and a dummy for household's access to electricity are used as instruments. Unlike Ackerberg and Botticini (2002), who used a two stage IV method, this study uses fixed effect IV model. The argument behind using a fixed effect model is that, there may be some time-constant unobserved factors (such as unobserved inherit heterogeneity) that affect contract choice dummies. Thus, simple two stage method may suffer from this heterogeneity bias.

III. DATA AND SUMMARY STATISTICS

Data

The data for the analysis are drawn from a repeat survey of a nationally representative sample of rice farmers in rural Bangladesh conducted to assess changes in rural livelihood. The benchmark survey was carried out in 2000-2001 by International Rice Research Institute among 1,880 rural households from 62 villages in 57 out of 64 districts in Bangladesh. This was done for a study to analyse/evaluate the impact of rice research on poverty reduction in Bangladesh sponsored by International Food Policy Research Institute (Hossain *et al*. 2003). The sample was drawn by using a multistage random sampling method. In the first stage, 64 unions were randomly selected from a list of all unions in the

country. In the second stage, one village was selected from each union that best represented the union with regard to the size of land holding and literacy rate. A census of all the households in the selected villages was conducted to stratify the households by the size of landownership and land tenure. A random sample of 20 households was drawn from each village such that each stratum is represented by its probability proportion. The final wave was conducted by IRRI in 2003-2004 following the households included in the first two waves and their descendants. The sample size of households increased to 1,927 in the last wave.

Among characteristics of the sample households, the average size of cultivated land per household decreased over time from 0.53 ha in 2000 to 0.48 ha in 2004, attributable to the division of land with the splitting of households over time. So far as tenancy status is concerned, owner farmers constituted the largest group of households. Over 2000-2004 period, however, the proportion of owned farms declined substantially from 37% to 26%, while that of pure tenant farmers increased from 9% to 17%. The area under tenancy increased from 33% in 2000 to 40% in 2004.

Summary Statistics

The data set for the analysis consists of information on different categories of farmers such as the owner farmers, the landlords and the tenant farmers on demographic characteristics of the household as well as characteristics of the plots that they own or rent from others. The variables that were used in the estimation process are the following:

(a) The landlord's and the tenant's productive characteristics and assets are the age, education, health status and primary occupation of the household or the household head, the number of adult and dependent household members, number of male and female agricultural labourers in the household. The study uses households' wealth as measured by all land properties owned by a household, household's debt to capital ratio and household's debt to per capita income ratio. Finally, a dummy variable is used in which households assess their economic conditions according to their living standard categories: rich, middle class, poor and very poor. These are used as proxies for risk attitude of the farmers.

(b) Plot level characteristics that affect production are the plot size, dummy for whether the plot has irrigation and dummy for soil type.

(c) Ecosystem variables that also affect the outcome which are dummy variables for flood prone, draught prone, favourable and irrigated plot.

(d) Average rainfall which differs in both year and among the districts.

Table I presents the summary statistics of the some of the important variables that are used in the estimation. It is observed that tenant farmers have more debt to capital burden and debt to income burden than the landlord farmers while their total wealth is lower than that of the landlord farmers. Table II presents some cross tabulations of three variables for the aggregate and for the seven major divisions separately. The variables used in the cross tabulations are crop practice among the tenant farmers who cultivate under two major types of tenancy contracts: sharecropping contract and fixed rent contract and the level of their debt to capital ratio. Crop practice is defined by 0 for mono cropping, 1 for double cropping and 2 for triple cropping.

Few interesting observations can be made from the summary statistics presented in Table II. First, the practice of mono cropping is associated more with share contracts than with fixed rent contracts, while double cropping cultivation seems to be associated more with tenants who cultivate under fixed rent contract. Second, as one looks across contracts for a given crop practice, the mean tenants debt to capital is higher under crop share contracts than under fixed rent contracts (mean of tenant's debt to capital ratio are in the parenthesis). These indicate that poorer tenants primarily cultivate under share contract and choose mono cropping. Tenants with less debt burden choose more double cropping and cultivate under fixed rent contract. This suggests presence of some possible matching between crop practice and tenant's degree of risk aversion[4]. Third, there are variations in the crop practice among the seven administrative divisions in Bangladesh. This supports the fact that there are differences in the market distribution among these divisions as well.

TABLE I
SUMMARY STATISTICS

Variable	Description	Mean	Standard deviation
tenant	If rent in >0	0.401	0.407
landlord	If rent out >0	0.487	0.658
share	=1 if share cropping in	0.739	0.438
crop_practice	=0 if mono crop; 1 if double crop; 2 if triple crop	0.671	0.581
mono cropping	=1 if mono crop	0.386	0.487
double cropping	=1 if double crop	0.554	0.497
triple croppimg	=1 if triple crop	0.058	0.234
t_debt_capital	tenant's liquidity constraint/ tenant's working capital	0.448	3.790

(Cont. Table I)

[4] Ackerberg and Botticini (2002) found similar correlation between tenant's wealth and crop type.

Variable	Description	Mean	Standard deviation
l_debt_capital	landlord's liquidity constraint/ landlords working capital	0.126	1.471
t_wealth	tenant's own cultivable land + homestead and other land	0.159	0.512
l_wealth	landlord's own cultivable land + homestead and other land	0.248	0.764
t_debt_income	tenant's liquidity constraint/ tenant's per capita income	0.251	0.788
l_debt_income	landlord's liquidity constraint/ landlord's per capita income	0.100	0.516

Source: Author's calculation.

TABLE II
DISTRIBUTION OF CROP PRACTICE, ELECTRICITY AND CONTRACT

Crop practice	Contract (%)		
	Share = 1	Fixed = 0	Total
Mono cropping			
0	44.76	57.25	55.77
1	55.24	42.75	44.23
Double cropping			
0	48.34	45.65	47.64
1	51.66	54.35	52.36
Triple cropping			
0	96.42	97.10	96.60
1	3.58	2.90	3.40
Electricity			
0	49.87	29.71	44.61
1	50.13	70.29	55.39

IV. RESULTS AND DISCUSSIONS

The analysis presents two sets of empirical results to identify the existence of possible assortive matching in the choice of a tenancy contract. The first set of results focus on the presence of matching between tenant farmers and crop intensity. The second set include matching between the landlord (the tenant) and the tenant (the landlord). The analysis then turns to contract choice by tenant farmers where it represents both results from a naive contract choice equation without controlling for possible matching and the results which consider the presence of such matching.

Crop Practice and the Tenant's Characteristics

As suggested in section III, the first step toward reviewing potential matching problems is to check correlations between observable crop practice and agent characteristics. Table III addresses this question by regressing choice of

crop practice on tenant's observable risk preferences. The results confirm a significant and negative relation between choice of crop practice and tenant's wealth, which is also a proxy for tenant's degree of risk aversion. It indicates that the probability of mono cropping increases with the increase of tenant's risk aversion.

TABLE III
ESTIMATION RESULTS FOR CROP PRACTICE (DEPENDENT VARIABLE: 0 IF MONO CROP, 1 IF DOUBLE CROP AND 2 IN TRIPLE CROP)

Variables	Fixed effect model	Logit model
t_debt_capital	-0.013*	-0.047*
	(0.003)	(0.022)
t_agri_male	-0.015	0.090
	(0.053)	(0.101)
t_agri_female	-0.192	0.358
	(0.246)	(0.553)
t_age_head	-0.021	-0.027
	(0.027)	(0.032)
t_age_head2	0.0003	0.003
	(0.0003)	(0.003)
t_prime_occupation	-0.044*	0.042
	(0.008)	(0.161)
t_cow_pp	6.00e-06	6.44e-06
	(3.5e-06)	(6.31e-06)
t_hhsize	0.068	0.067
	(0.048)	(0.086)
t_healthy_population	-0.045	-0.065
	(0.046)	(0.086)
t_depen-ratio	0.170	0.948**
	(0.236)	(0.373)
t_edu_active_labour	-0.004	0.011*
	(0.003)	(0.005)
constant	0.363**	0.415
	(0.208)	(0.903)
N	1174	1174
Wald chi 2 (19)		
F(18,999)	3.72	
LR chi2 (19)		62.62

F test that all u_i=0: F(1528, 558) = 1.07 Prob > F = 0.1842

* significant at 5% level, ** significant at 10% level.

Note: all equations control for average rainfall in different districts (64 districts) in 2000 and 2004, dummies for soil type and dummies for ecosystem: fp- flood prone, dp- draught prone, fav-favourable, ir- irrigated.

To investigate this channel of possible matching the analysis estimates two models: random effect and household-year fixed effect models and then compare results of random effect model and fixed effect model using Hausman test. Results of the Hausman test show that fixed effect model gives more consistent results than random effect model. Moreover, as crop practice is a discrete choice variable, the same regression also tested with a logit model assuming non-linearity. The results of the logit model are similar to the results from other two models. The regression results in all three models suggest that the tenant household's degree of risk aversion determine the type of crop practice. The explanation behind this relationship is fairly intuitive. In the absence of any insurance market, farmers have to be concerned about unobserved output losses due to environmental factors such as flood or draught. Therefore, even if multi cropping pattern would increase the outcome, this also involves high unobserved risk. However, as Ackerberg and Botticini (2002) mentioned, it does not explain why there is such matching. It can be interpreted as, if unobservable risks of production are very important, more risk averse tenant choose mono cropping. Another implication from such estimation is the direction of the biases in the contract choice equation. Since cropping practice is negatively related with observed proxies for risk aversion, it may also be correlated with unobserved component of risk aversion. This indicates negative bias of the crop practice coefficient.

Landlord's (tenant's) Risk Preferences on Tenant's (landlord's) Characteristics

Following Bellmare (2006) to facilitate identification whether there is endogenous matching between the landlord and the tenant farmer in the survey data we regressed two proxies of landlord's (tenant's) risk aversion on the tenant's (landlord's) characteristics. For the landlord farmer these two proxies are landlord's debt to income ratio (l_debt_income) and landlord's wealth as represented by the entire land asset a household has (l_wealth). Similarly, for the tenant farmer, the proxies for risk aversion used in the regression are tenant's debt to capital ratio (t_debt_capital) and tenant's level of wealth (t_wealth).

Table IV and V present the results of the regression using fixed effect models. The estimated coefficients show that the landlord's degree of risk aversion is significantly correlated with tenant's experience (t_age) and number of healthy population in the household (t_healthypp). Thus, less risk averse landlord tends to match with a tenant household that has less experience and less healthy members. Under the standard principal agent model less risk averse landlord may choose more risk averse tenant because the landlord can offer a contract with less incentive package and can reduce cost of his contract. Again this would be possible because more risk averse tenants have low reservation utility.

TABLE IV

ESTIMATION RESULTS FOR LANDLORD'S RISK PREFERENCES ON TENANT'S CHARACTERISTICS (FIXED EFFECT MODEL)

Variables	l_debt_income	l_wealth
t_debt_capital	0.003	-0.001
	(0.004)	(0.003)
t_ngom	0.090	0.103
	(0.057)	(0.077)
t_offfarm_income	5.04e-06	7.17e-06
	(6.69e-06)	(7.96e-06)
t_hhsize	0.043	0.116*
	(0.032)	(0.036)
t_depen-ratio	-0.082	-0.174
	(0.181)	(0.195)
t_age_head	-0.008**	-0.019**
	(0.003)	(0.005)
t_age_head2	0.0001*	0.0002*
	(0.00005)	(0.00006)
t_edu_active_labour	0.0009	-0.0008
	(0.0002)	(0.004)
t_healthy_population	-0.057	-0.113**
	(0.037)	(0.035)
constant	0.384*	0.739*
	(0.210)	(0.201)
N	2105	2105
F(18,1528)	1.25	4.35

* significant at 5% level, ** significant at 10% level.

Note: All equations control for average rainfall in different districts (64 districts) in 2000 and 2004, dummies for soil type and dummies for ecosystem: fp- flood prone, dp- draught prone, fav-favourable, ir- irrigated. The estimation also checks with random effect model and compares random effect vs. fixed effect using Huasman test. Huasman test shows that fixed effect model estimations are consistent over random effect model.

TABLE V
ESTIMATION RESULTS FOR TENANT'S RISK PREFERENCES ON LANDLORD'S CHARACTERISTICS (FIXED EFFECT MODEL)

Variables	t_debt_capital	t_wealth
l_debt_capital	0.125	-0.014
	(0.080)	(0.017)
l_debt_income	0.222	0.024
	(0.145)	(0.043)
l_ngom	0.247	0.060
	(0.399)	(0.080)
l_offfarm_income	4.38e-06	-6.80e-06
	(2.84e-06)	(4.42e-06)
l_hhsize	-0.224	0.017
	(0.268)	(0.039)
l_depen-ratio	-0.316	0.168
	(0.639)	(0.195)
l_age_head	-0.023	-0.002
	(0.019)	(0.004)
l_age_head2	0.0002	8.31e-06
	(0.016)	(0.00004)
l_edu_active_labour	0.002	0.002
	(0.016)	(0.003)
l_healthy_population	0.222	0.023
	(0.302)	(0.043)
constant	0.818*	0.164*
	(0.477)	(0.126)
N	2100	2127
F(18,1525)	0.95	0.77

* significant at 5% level, ** significant at 10% level.

Note: All equations control for average rainfall in different districts (64 districts) in 2000 and 2004, dummies for soil type and dummies for ecosystem: fp- flood prone, dp- draught prone, fav-favourable, ir- irrigated. The estimation also checks with random effect model and compares random effect vs. fixed effect using Huasman test. Huasman test shows that fixed effect model estimations are consistent over random effect model.

Conversely, the estimated results between the tenant's risk preferences and the landlord's characteristics show no significant impact. These results can be interpreted in such a way that in rural Bangladesh, with the availability of abundant tenant farmers especially during the peak cropping season, the landlord chooses his tenant farmer according to his own risk preferences. As labourers are abundant, the tenants have little scope to decide over choosing a landlord.

Selecting Instruments

In the choice of instruments, following Ackerberg and Botticini (2002), this paper uses non-overlapping geographical distribution to achieve such identification. The estimation includes divisional dummies as instruments which represent different market facilities. Moreover, it includes a dummy for access to electricity in the villages from 1987 to 2004 and another dummy for access to electricity by the landlord households. The intuition behind using electricity as an instrument is derived from the fact that access to electricity in rural Bangladesh represents socioeconomic development. It has been argued that lack of access to electricity is one of the major impediments to development. Several studies (Barnes, Khandker and Samad 2010) found that electrification has a significant positive impact on household's social status, income and educational outcome. In the survey data the households were asked if they have access to electricity from 1984 to 2004. Thus, access to electricity affects tenancy contract choice only through its direct effect on household's risk preferences.

Contract Choice Equation

Table VI shows the estimated results of contract choice equation using a fixed effect model where dependent variable is 1 if the tenant farming households cultivate under share contract and 0 if they cultivate under fixed rent contract. The Table presents two results, with and without controlling for endogenous matching. The endogenous variables are: crop practice, l_debt_income and l_wealth.

Estimation results in Table VI indicate that without controlling for endogenous matching there is strong effect of the landlord's proxies for risk attitudes on contract choice by the tenants. This implies that if one overlooks the presence of assortive matching, the survey data allows one to accept the risk sharing hypothesis. For example, landlord's level of debt to capital ratio has significant positive effect on the choice of crop share contract by the tenant farmer.

The last column of the Table presents results of two stage model where it controls for endogenous variables. In the two stage model, among significant coefficients, tenant's choose share contract if their self economic evaluation moves from rich to poor depending on the experience of past years. This shows that in rural Bangladesh poor tenants (hence more risk averse) are more likely to choose crop share contract over fixed rent contract. Among the other characteristics, aged households choose share cropping contract. Tenants are more likely to choose fixed rent contract if the farming households have more educated and healthy members. This is consistent with the proposition that

tenant's own risk attitudes play a vital role in choosing a particular contract. However, after controlling for the biases due to endogenous matching, the analysis finds no significant effect of the landlord's risk preferences on contract choice by the tenant farmers. It implies that in rural Bangladesh farmers' own degree of risk aversion is more important than risk sharing opportunities during production process. These findings are exactly opposite to the findings of Ackerberg and Botticini (2002) who used data from Renaissance Tuscany. However, our results are similar those obtained by Bellmare (2006) using data from Madagascar.

TABLE VI

ESTIMATION RESULTS OF TENANCY CONTRACT CHOICE MODEL

Variables	Fixed effect without IV	Fixed effect with IV
t_debt_capital	-0.009	-0.011
	(0.042)	(0.054)
t_selfeco	0.268*	0.235**
	(0.102)	(0.138)
t_hhsize	0.097	0.138
	(0.075)	(0.102)
t_femaleh	0.514	0.210
	(0.422)	(0.572)
t_depen_ratio	-0.605**	-0.386
	(0.369)	(0.533)
t_agehead	0.106**	0.122**
	(0.063)	(0.084)
t_agehead2	-0.001*	-0.001**
	(0.0006)	(0.0009)
t_agri_male	0.243**	0.229
	(0.125)	(0.158)
t_agri_female	0.517	0.561
	(0.558)	(0.689)
t_cowpp	5.54e-06	1.60e-06
	(0.00001)	(0.00002)
t_primary_occu	0.158	0.182
	(0.171)	(0.212)
t_edu_active_labour	0.023*	0.018**
	(0.008)	(0.010)
t_healthy_popu	-0.132*	-0.152**
	(0.062)	(0.081)
l_own_land	2.648	1.576
	(1.939)	(3.393)

Variables	Fixed effect without IV	Fixed effect with IV
l_agehead	-0.012	-0.014
	(0.013)	(0.018)
l_debt_capital	0.912**	0.711
	(0.555)	(0.855)
l_healthy_popu	0.242*	0.120
	(0.109)	(0.216)
l_debt_income	-2.021**	-0.960
	(1.121)	(2.460)
l_wealth	-12.693*	-2.082
	(5.502)	(15.133)
crop_inten	0.491*	0.303
	(0.117)	(0.214)
constant	-2.903*	-3.011
	(1.714)	(2.173)
N	506	506
F(464,14)	3.36	2.20
Prob>F	0.0059	0.0451

* significant at 5% level, ** significant at 10% level

Note: All equations control for average rainfall in different districts (64 districts) in 2000 and 2004, dummies for soil type and dummies for ecosystem: fp- flood prone, dp- draught prone, fav-favourable, ir- irrigated. The estimation also checks with random effect model and compare random effect vs. fixed effect using Huasman test. Huasman test shows that fixed effect model estimations are consistent over random effect model.

V. CONCLUSION

The standard contract theory hypothesises that there exists a link between certain characteristics of the contracting parties and the activities. However, it is difficult to find all paths of such relationship through empirical studies. This analysis adds to the empirical literature on agricultural tenancy contracts by applying the econometric method proposed by Ackerberg and Botticini (2002) to IRRI survey data for rice farmers of rural Bangladesh. The method justifies the potential impact of endogenous matching between the principals, the agents and the activities on the estimated results. The estimation process at first search for the possible channels of the presence of endogenous matching. After finding evidence of matching that may give bias estimation, the contract choice equation is estimated using instrumental variables approach to correct for the impact of endogenous matching.

The study finds support of tenant's observable proxy for risk aversion impacting on the decision to grow one or more crop during a cropping year under

formal contract agreements. These are largely consistent with theoretical predictions. For example, farmers who have higher debt to capital burden are more likely to choose mono cropping. This is also because while cultivating more than one crop would be profit maximising, there seems to more unobservable risks related to each type of crop cultivation process. Furthermore, the study finds that the landlord's observable risk averseness is significantly related with the tenant's characteristics. This implies that in rural Bangladesh where there are abundant agricultural labourers available, the landlords (with specific characteristics) look for the tenants with specific characteristics. However, the analysis finds almost no evidence of observed landlord characteristics impacted on the tenant's degree of risk aversion.

With the contract choice equation, naïve estimates ignoring such matching can give confusing results. Tenant's choice of contract between crop share contract and fixed rent contract largely depend on his own characteristics and also degree of risk aversion of the landlord farmers in the naïve estimation without controlling for matching. Whereas, after controlling for matching, the analysis finds no significant evidence of risk sharing, and tenant's choice of a particular tenancy contract largely depend of his own ability and degree of risk aversion in rural Bangladesh. These results should, however, be interpreted with care due to the data limitations. In particular, endogenous matching can be understood more clearly if the data sets have information on actual matching partners between two contracting parties.

Despite above limitations, the findings of this study have important implications in the context of most developing countries. In the absence of insurance market or any intervention, with a large number of population involved in the farming activities, the landlord farmers can exert their monopoly power. This monopoly power of the landlord farmers may also limit the bargaining power of the tenant farmers with respect to terms and conditions of the contract. These findings match with other empirical works that used data from other developing countries. As many developing countries around the world have similar attributes, the findings of this study can provide important insight into current policy debates on tenurial arrangements, especially contractual choice, and the potential for government interventions in agriculture.

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APPENDIX

TABLE I
ESTIMATION RESULTS OF MARGINAL EFFECT FOR CROP PRACTICE DEPENDENT VARIABLE: 0 IF MONOCROP, 1 IF BICROP AND 2 IN TRICROP

Variables	Marginal effect
t_debt_capital	-0.012*
	(0.005)
t_agri_male	0.020
	(0.023)
t_agri_female	0.089
	(0.113)
t_age_head	-0.006*
	(0.002)
t_age_head2	0.00005*
	(0.0003)
t_prim_occupation	-0.005
	(0.037)
t_cow_pp	1.68e-06
	(0.0000)
t_hhsize	0.015
	(0.020)
t_healthy_population	-0.013
	(0.021)
t_depen-ratio	0.217*
	(0.087)
t_edu_active_labour	-0.002
	(0.013)
Prob (y)	0.619