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IMPACT OF SUPPLY-SIDE MARKET PARTICIPATION ON PROFIT OF CATFISH FARMERS IN DELTA CENTRAL AGRICULTURAL ZONE, DELTA STATE, NIGERIA

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ABSTRACT
In small or less developed markets it is difficult to identify market opportunities, poor market access, distance covered to market farm produce and the decision to participate due to high transportation cost. Thus, evaluation of market participation on profit is based on an observational study instead of an experimental design with conditional exogeneity. What is needed is an estimation technique that corrects for self-selection based on observed characteristics and/or unobserved characteristics where market participation decision is assumed to be endogenous. This study, therefore, estimated the effect of supply-side market participation on profit amongst small-holder catfish farm families in Delta Central Agricultural Zone of Delta State, Nigeria using the endogenous switching regression (ESR) model on data collected from a random sample of 272 catfish farmers. The results showed that there are unobserved self-selection and heterogeneous effects between market participant and non-participant groups given the same catfish production control variables. In addition, catfish farmers are more likely to participate in fish marketing with increased marketable surplus, smaller household size, more education, more experience in fish farming, younger the household-head, more fish output and married male household-head. Among the catfish farmers, non-participants in catfish market earn less than a random catfish farmer would have earned when not participating in fish markets. Catfish market participants earn higher profit than a random catfish farmer from the catfish farm sample would earn when participating in the market. On the average, the market participants have higher profit level than their counterparts who are non-participants in the market. The study, therefore, calls for policies aimed at improving access to catfish production information by catfish farmers for enhanced marketable surplus. Provision of inputs at subsidized prices especially targeted at younger fish farmers for increased marketable surplus in the study area.

Keywords: Self-selection, ESR, market-participation, profit, and Delta State

Introduction

Farming is a business meant to earn income for household, with participation in market higher if expected profits from producing for the markets are higher than regular profits (Frank and Cartwright, 2016). The trend is that smallholder farm families in developing countries including Nigeria participate in the market more as net-buyers than as net-sellers (Ferris, Okoboi, Crissman, Ewell and Lemaga, 2001; Nkonya and Kato, 2001; Aliguma, Magala and Lwasa, 2007) despite its supply-side benefits (Omiti, Otieno, Nyanamba, and McCullough, 2009; Wickramasiughe, Omot, Patiken and Ryan, 2014). There are many studies on market participation and its determinants (Barret, 2008; Gani and Adeoti, 2011; Sebatta, Mugisha, Katungi, Kashaaru, and Kyomugisha, 2014; Kiwanuka and Machethe, 2016). However, the focus has been on the role of transactions cost and market failures on the decision of smallholder farmers to participate in market (Goetz, 1992).

In addition, existing literatures used models for smallholder market participation that characterize decisions as probability of participating in the market and volume sold, if participating in market (Bellemare and Barrett 2006; Goetz 1992; Holloway, Barrett, and Ehui, 2005; Key, Sadoulet, and DeJanvry 2000). Some studies have adopted some forms of *double-hurdle*, *two-stage*, partial randomization with common impact or *type-2 tobit* model two-step sample selection model (Olwande and Mathenge, 2012; Reyes *et al.* 2012; Makhura, *et al.* 2001; Boughton *et al.* 2007; Alene *et al.* 2008; Omiti *et al.*, 2009; Siziba *et al.* 2011; Holloway *et al.*, 2005; and Martey *et al.* 2012) to model market participation while some others adopted the switching regression model (Vance and Geoghegan, 2004) depending on the decision process of interest.

In small or less developed markets with less commercialization and more home-oriented production, it is not only difficult to identify market opportunities, poor market access and the distance covered to market their produce but the decision to participate due to high transportation cost. The evaluation of income effects of market participation is, however, based on an observational study instead of an experimental design with conditional exogeneity (Khandker, *et al.,* 2010; Duflo, *et al.,* 2006). What is needed, therefore, is an estimation technique that corrects for self-selection based on observed characteristics and/or unobserved characteristics. One technique is the Endogenous Switching Regression (ESR) model that solves for selectivity effects caused by observed and unobserved differences between the counterfactual and the group under study (Di Falco, *et al.,* 2011). It also allows for heterogeneity, where market participation decision is assumed to be endogenous (Di Falco, *ibid*).

Catfish farmers in Delta state have been considered as marginal players in fish production due to their low capacity to generate income, possibly due to unfavourable climatic conditions for production, without recourse to market-oriented supply-side. This study, therefore, examined supply-side impact of market participation on profit amongst small-holder catfish farm families in Delta State, Nigeria.

Methodology

Survey was conducted among catfish farmers in Udu and Uvwie Local Government Areas (LGAs) in Central Agro-ecological Zone of Delta state, Nigeria to elicit information on smallholder catfish farmer market participation. The Central Agricultural Zone of the State covers 9 LGAs (Ethiope East, Ethiope West, Okpe, Sapele, Udu, Ughelli North, Ughelli South, and Uvwie). The area is under mangrove, fresh water and rain, forests vegetative cover. Agriculture and agro-related activities are the major occupations of the population of the area. The climate favours the production of various food and cash crops. Animals reared include fish, poultry, goats, sheep, cane rats, snails and bees. The area is known for its farm and non-farm activities. Udu LGA occupies a land of about 138km^2 with Otor-Udu as headquarters and a population estimate of approximately 100,000 people (NPC, 2006). The land is interlocked by river. It has tropical weather and rainforest with ever-green vegetation and plantation all year round. Its geography feature consists of numerous streams that inter-connect into an intricate web of rivers, lagoons, swamps and wetland. Uvwie has a land mass of 95.0km^2 with its administrative headquarters in Effurun. It has a population estimate of 188,728 people with 93,999 male and 94,729 female (NPC, 2006).

A three-stage sampling procedure was used for the study. In the first stage, Udu and Uvwie LGAs were purposively chosen for the study because of the need to study lowland agricultural systems in Delta state with less commercialization, and more home-oriented production. This area has less favourable climatic conditions and low capacity of farmers to generate incomes far below that in the highland. Hence, lowland fish farmers were considered as marginal players in fresh fish production with their operating environment considered suitable for a study of factors limiting fish farmer household participation in local markets. In the second stage, three (3) communities were selected from each LGA using simple random sampling technique. The two communities were Ekpan, Ugboroke and Jakpan for Uvwie LGA, and Oghior, Ubogo and Ugbisi communities for Udu LGA. The sample size for the study in each community was determined using the sample-size estimator following Ojogho and Ojo (2017), given estimates of catfish output variance for each community, from a pilot survey, at 95% confidence interval and a 0.03 margin of error. The sample-size estimator is given as:

$$n_i = \frac{z^2_{\alpha/2} s^2_i}{e^2 + \frac{z^2_{\alpha/2} s^2_i}{N_i}} \qquad (1)$$

where $z_{0.025} = 1.96$, s^2_i is the fish output variance of the i^{th} community; N_i is the target population of catfish farmer of the i^{th} community and $e = 0.03$. A simple random sample of catfish farmers in each community was taken from the list of the target population in the region developed from the pilot survey of catfish farmers classified as participants if the market participation was greater than or equal to 0.5, or otherwise. Using the estimator, 146 fish farmers were sampled from Udu LGA consisting of 76 non-participants in catfish marketing and 70 catfish participants, and 154 fish farmers from Uvwie LGA (74 non-participants and 80 participants) out of a target population of 170 and 192 catfish farmers in Udu and Uvwie LGAs respectively. However, 272 catfish farmers provided useful information for data analysis. This was made up of 69 non-participants and 64 participants in Udu, and 67 non-participants and 73 participants in Uvwie. The price of inputs were measured as the sum of the transactions cost incurred by a fish farmer and the retail prices in ₦ per unit, while the quantity of fish produced by a fish farmer was the quantities produced from own-farm.

Model specification

Market participation for catfish farmers was modelled under the Random utility Theory (RUT) given that catfish farm families will choose between market participation and non-participation based on the profit they make. The study assumed, first, that catfish farm families are risk neutral, and their decision to participate in market as sellers was influenced by the profit derivable from catfish marketing. The study further assumed that every rational catfish farm family chose the regime with the highest profit. Under these assumptions, the profit derived from fish market participation was y_{mp}, and the profit from non-participation was represented as y_{nmp}. The two regimes were specified, mathematically, as:

$$y_{imp} = \boldsymbol{x}_i \boldsymbol{\beta}_{mp} + \mu_{imp} \quad (2)$$

$$y_{inmp} = \boldsymbol{x}_i \boldsymbol{\beta}_{nmp} + \mu_{inmp} \quad (3)$$

Where $\boldsymbol{x}_i$ is a vector of variable factor prices, independent factors of farm and household characteristics; $\boldsymbol{\beta}_{mp}$ and $\boldsymbol{\beta}_{nmp}$ are the parameter estimates for market participation and non-participation regimes respectively; μ_{imp} and μ_{inmp} are the error terms, assumed to be independent and identically distributed.

The perceived benefits of market participation derived was represented by a latent variable D_i^*, expressed as a function of the observed characteristics and attributes of fish farmers, denoted as Z, in a latent variable model given as:

$$D_i^* = \boldsymbol{\gamma} z_i + \varepsilon_i \begin{cases} D_i = 1 \text{ if } D_i^* > 0 \\ D_i = 0 \text{ if } D_i^* \leq 0 \end{cases} \quad (4)$$

Where D_i is a dummy variable that equals 1 for farmers who participated in fish marketing, and zero otherwise. $\boldsymbol{\gamma}$ is a vector of parameters to be estimated. A catfish farm family was assumed to only participate in market if the perceived net benefits were positive. The error term, ε_i with zero mean and variance σ_ε^2 captures measurement errors and factors unobserved to the researcher but known to the farmer. Variables in $\boldsymbol{z_i}$ include factors that influence catfish market participation. Given that catfish farmers choose to either participate or not participate in fish marketing, the observed net benefits take the values:

Regime 0: $y_{imp} = \boldsymbol{x}_i \boldsymbol{\beta}_{mp} + \mu_{imp}$, if $D_i = 0$ (5)

Regime 1: $y_{inmp} = \boldsymbol{x}_i \boldsymbol{\beta}_{nmp} + \mu_{inmp}$, if $D_i = 1$ (6)

Market participation was measured as the ratio of percentage value of marketed output to total farm production (Haddad and Bouis, 1990; Omiti *et al.*, 2009). The three error terms, μ_{imp}, ε, and μ_{inmp} were assumed to have a trivariate normal distribution with mean vector zero and covariance matrix given as:

$$cov(\mu_{imp}, \mu_{inmp}, \varepsilon) = \begin{bmatrix} var(\mu_{imp}) & cov(\mu_{imp}, \mu_{inmp}) & cov(\mu_{imp}, \varepsilon) \\ cov(\mu_{inmp}, \mu_{imp}) & var(\mu_{inmp}) & cov(\mu_{inmp}, \varepsilon) \\ cov(\varepsilon, \mu_{imp}) & cov(\varepsilon, \mu_{inmp}) & var(\varepsilon) \end{bmatrix} \quad (7)$$

The values of the truncated error term $(\mu_{inmp} \mid D_i = 1)$ and $(\mu_{imp} \mid D_i = 1)$ were then given as;

$$(\mu_{inmp} \mid D_i = 0) = E\left((\mu_{inmp} \mid \varepsilon_i \leq -\boldsymbol{\gamma} z_i') = \sigma_{\varepsilon_{nmp}} \frac{-\phi\left(\frac{\gamma z_i'}{\sigma}\right)}{1-\Phi\left(\frac{\gamma z_i'}{\sigma}\right)} \right) \equiv \sigma_{\varepsilon_{nmp}} \lambda_{nmp} \quad (8)$$

$$(\mu_{imp} \mid D_i = 1) = E\left((\mu_{imp} \mid \varepsilon_i \leq -\boldsymbol{\gamma} z_i') = \sigma_{\varepsilon_{mp}} \frac{-\phi\left(\frac{\gamma z_i'}{\sigma}\right)}{1-\Phi\left(\frac{\gamma z_i'}{\sigma}\right)} \right) \equiv \sigma_{\varepsilon_{mp}} \lambda_{mp} \quad (9)$$

Where ϕ and Φ are the probability density and cumulative distribution function of the standard normal distribution respectively. The ratio of ϕ to Φ evaluated at $\gamma z_i'$ is referred to as the inverse Mills ratio, λ_{mp}, λ_{nmp} or the selectivity terms. The selectivity terms were incorporated into equation (8) and (9) to account for selection bias. The model was estimated using the full information maximum likelihood method suggested by Lokshin and Sajaia (2004) through a simultaneous estimation of the market-participation and outcome equations, in order to obtain consistent standard errors without complex adjustments and overcome the residual heteroskedastic problem. Endogenous switching was considered present if either the correlation between the error term of the participation equation and the outcome equation $\rho_{mp,\varepsilon} = \frac{\sigma_{mp,\varepsilon}}{\sigma_{mp}\sigma_{\varepsilon}}$ or the correlation between the error term of the participation equation and the outcome equation, $\rho_{nmp,\varepsilon} = \frac{\sigma_{nmp,\varepsilon}}{\sigma_{nmp}\sigma_{\varepsilon}}$ was significantly different from zero. If $\rho > 0$, this would mean negative selection bias, implying that farmers with below average profit are more likely to participate in market. On the other hand, if $\rho < 0$, implies positive selection bias, suggesting that farmers with above average profit are more likely to participate in market.

Results and Discussion

The results of the summary statistics for costs, returns and profit are presented in Table 1. The results showed that total variable cost had the larger share (73.56%) in the total cost among participants of catfish marketing in the study area with fixed cost accounting for about 26.44%. This suggests that for every ₦1.00 invested in catfish production in the study area by participants in catfish marketing, about 74k was spent on variable inputs while 26k was incurred by the farmer irrespective of their production level. Among the variable costs, labour cost accounted for the largest share (58%) consisting of 57.69% and 58.31% among participants of fish marketing and non-participants respectively. This is followed by the cost of catfish stocked (27.76%) consisting of 28.30% and 27.25% for participants and non-participants respectively in the study area. The cost of land in the study area had a higher share (16.90%) consisting of 16.68% and 17.12% among participants and non-participants respectively than water pump. Participants of fish marketing enjoyed lower cost share in the cost of variable inputs.

The results also showed that total variable cost had the larger share (76.72%) in the total cost among non-participants with fixed cost accounting for only 23.28%. This suggests that for every ₦1.00 invested in catfish production in the study area by non-participants, about 77k is spent on variable inputs while 23k is incurred by the farmer on fixed inputs, irrespective of their production level. Among the variable costs, labour cost accounted for the largest share of both the total variable cost (58.31%) and the total cost (44.88%) among non-participants in the study area. This is followed by the cost of catfish stocked with 27.25% and 20.82% respectively in total variable cost and total cost. This suggests that for every ₦100 each invested in variable cost and total cost of catfish production, ₦27.25 and ₦20.82 was spent on cost of catfish stocked respectively. However, non-participants enjoyed lower cost share in cost of land and water-pump for fish production. With a total cost of ₦159.16 and total revenue of ₦ 219.25, participants in fish marketing had a gross margin of ₦101.63 and profit of ₦60.08. Similarly, with a total cost of ₦142.31 and total revenue of ₦ 192.72, participants had a gross margin of ₦ 82.39 and a profit of ₦ 50.41. This therefore suggests that fish farming in the study area is profitable.

Table 2 shows the results of the independent t-test to determine significant differences in the use of input, and profit between participants and non-participants in catfish marketing. The results showed that catfish farmers who are non-participants had less profit (50.42 ± 3.91) compared to participants (60 ± 5.20). The mean profit difference between catfish farmer market participants and non-participants was (9.67 ± 3.81) and significant at 1% level. This implies that profit from catfish production has a positive correlation with market participation. It also implies that most catfish farmer market participants earn more profit from catfish production than their counterparts whom are non-participants. Similarly, catfish farmers who are non-participants had lower total variable cost (110.34 ± 9.06) compared to participants (117.62 ± 17.90). There was significant difference in the total variable cost between participants and non-participants. This implies that total variable cost from catfish production has a positive correlation with catfish market participation. It also implies that most catfish farmer market participants spend more on catfish production than non-participants with increase in production level. Also, catfish farmers who are non-participants had lower total fixed cost (31.72 ± 3.21) compared to participants (41.54 ± 7.30). There was significant difference in the total fixed cost between participants and non-participants. This implies that total fixed cost on catfish production has a positive correlation with catfish market participation. It also implies that most catfish farmer market participants incur more on fixed inputs in catfish production than non-participants. The results imply that there is significant difference between participants and non-participants of catfish marketing in Delta state.

Results of the Full Information Maximum Likelihood estimates of the Endogenous Switching Regression (ESR), with profit in logarithmic form as the dependent variable, are summarized in Table 3. The result of the likelihood-ratio test for joint independence of the selection and profit equations shows that the profit equations of catfish farmer participants and catfish farmer non-participants in catfish marketing are significantly different at 1% level of significance. The cost of feed and fertilizer had significant negative effects on profit for participants and significant positive effect on profit for non-participants. This implies that there are heterogeneous effects between participants and non-participants given the same control variables. These indicate that there are both unobserved self-selection and heterogeneous effects between participant and non-participant groups. Both can be accounted for by the ESR model. Therefore, ESR seems to be the most promising estimation technique for catfish farmer market participation model specification compared to the other techniques. Consequently, any kind of model that assumes common impacts such as the partial randomization with common impact model is likely to give biased estimates.

The results in Table 3 also show estimates of ρ_1 for market participants and ρ_2 for non-participants in catfish marketing. Indeed, ρ_2 is significantly positive for market participants. This suggests that non-participants in catfish marketing earn less than random catfish farmers would have earned when not participating in catfish markets. This is in line with Lokshin and Sajaia (2004). ρ_1 is only significantly negative for catfish farmer market participants. According to Lokshin and Sajaia (*ibid*), it indicates that catfish market participants earn higher profit than a random catfish farmer from the catfish farm sample would earn when participating in catfish marketing. On the other hand, the parameter has a negative sign in the profit equation of non-participants, implying that without participating in catfish marketing, profit levels are significantly lower among non-participants, and non-participant would have had lower profit levels than participants if participants were fully involved in catfish marketing in the study area. Clearly, on the average, the market participants have higher profit level than non-participants.

The results of the determinants of catfish market participation in the selection equation show that catfish farmers are more likely to participate in catfish marketing the more marketable surplus they have, the smaller the household size, the more educated, more experienced in catfish farming, the younger the household-head, the more catfish output and for married male household-head. These are in line with *a priori* expectations. Also, the probability to participate in catfish marketing also seems to be higher for farms with larger farm size. The coefficients for specific costs are negative and significant. The cost of hired labour (-1.97), cost of stocking (1.94), feed cost (-2.73), cost of fertilizer (-0.013), cost of water pump (-2.17) and the cost of land (-2.38) significantly reduced the probability of participating in fish marketing. However, size of farm (2.13), number of ponds (1.86), and weight of catfish produced (2.62) increased the probability of participating in catfish marketing in the study area.

With regards to the profit equation for catfish market participants, the results show that most explanatory variables were statistically significant at 1% level (explaining profit level). Farm size (0.04), number of ponds (0.16), and output (0.003) were statistically significant at least 10% and had positive effect on profit. The elasticity coefficient reveals that profit level increased by 0.3% if output increases by 1%. This indicates catfish market participants could potentially increase their profit by increasing the output. Paid labour, farm size, stocking cost, feed cost, lime cost and fish output are more productive on fish farms for market participants and contribute more to profit. Among the non-participant in catfish marketing, only number of ponds (0.005) and output (0.004) were significant at 5% level or less in explaining profit levels. The elasticity coefficients indicate that output had stronger impact on profit and the coefficient of output was lower. Profit tends to be higher the more output, number of ponds and higher the farm size. In contrast, it decreased with increasing specific costs. This is in line with initial predictions from economic theory. The coefficients of stocking catfish were nearly same for market participants and catfish farms of non-participant, and were significant. Interestingly, their sign was also negative, which implies that the cost of stocking catfish in ponds tends to decrease profit. Farm size does not have a significant impact on farm income of non-participants in catfish marketing. Fertilizer cost, cost of land and cost of water pump were more productive on fish farms of non-participants and contribute more to profit as such.

Conclusion

This study examined impact of supply-side market participation on profit among small-holder catfish farm families in Delta State, Nigeria using the endogenous switching regression (ESR) model on data collected from a random sample of 273 catfish farmers. In Delta state, there are not only unobserved self-selection and heterogeneous effects between market participants and non-participant in catfish marketing groups given the same catfish farming control variables. Catfish farmers are more likely to participate in catfish marketing the more marketable surplus they have, smaller household size, more educated, more experienced in fish farming, younger the household-head, more catfish output and married male household-head. Non-participants in catfish marketing earn less than a random catfish farmer would have earned when not participating in catfish marketing. Catfish market participants earn higher profit than a random catfish farmer from the catfish farmer sample would earn when participating in fish marketing. On the average, the market participants have higher profit level than non-participants. The study, therefore, calls for policies aimed at improving access to catfish production information by catfish farmers for enhanced marketable surplus. Provision of inputs at subsidized prices especially targeted at younger fish farmers for increased marketable surplus in the study area.

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Table 1: Summary Statistics of Cost, Returns and Profit per Kg of Fish among Fish Farmers in the Study Area

Variable	**Participants of fish Marketing**				**Non-participants of fish marketing**				**Pooled sample**			
	Mean (₦)	Std. Dev	% of Vcost	% of Tcost	Mean (₦)	Std. Dev	% of Vcost	% of Tcost	Mean (₦)	Std. Dev	% of Vcost	% of Tcost
Variable cost												
Labour cost	68.33	61.95	57.69	42.58	65.69	36.31	58.31	44.88	66.99	5.03	58.00	43.74
Feed cost	11.10	10.66	9.44	6.94	10.63	5.59	9.81	7.49	10.86	0.84	9.63	7.22
Fish stocked cost	32.83	31.44	28.30	20.73	29.09	14.78	27.25	20.82	30.94	2.44	27.76	20.77
Lime cost	3.34	4.55	2.88	2.08	2.98	1.87	2.84	2.15	3.16	0.34	2.86	2.11
Fertilizer cost	2.01	1.97	1.69	1.23	1.93	1.04	1.79	1.38	1.97	0.16	1.74	1.30
Total Variable Cost	117.61	107.42	100.00	73.56	110.33	55.10	100.00	76.72	113.93	8.45		
Fixed Cost												
Land cost	26.48	21.89	-	17.12	22.44	10.89	-	16.68	24.44	1.72	-	16.90
Water pump cost	15.06	25.87	-	9.33	9.53	14.99	-	6.60	12.26	2.11	-	7.95
Total fixed cost	41.54	43.78	-	26.44	31.87	19.51	-	23.28	36.69	3.38	-	
Total cost	159.16	14.86			142.31	70.39			150.62	11.53		
Total revenue	219.25	22.95			192.72	19.66			205.80	21.24		
Gross Margin	101.63	28.46			82.39	22.78			91.88	25.58		
Profit	60.08	31.19			50.41	23.77			55.19	27.49		

Source: Computed from Field Survey, 2019; Vcost is variable cost; Tcost is total cost

Table 2: Result of Independent t-test between Participants and Non-Participants in Catfish marketing

Variable	Participants Mean	Non-participants Mean	Mean Difference	t-statistics
Profit	60.09	50.416	9.674***	2.557
	(-51.987)	(-3.987)	(-3.809)	
Labour cost	65.694	68.331	2.638***	2.843
	(-5.97)	(-10.326)	(-0.928)	
Feed cost	10.639	11.097	0.458***	3.053
	(-0.919)	(-1.777)	(-0.15)	
Fingerlings cost	29.09	32.834	3.744**	2.107
	(-2.43)	(-5.241)	(-1.777)	
Cost of lime	2.983	3.343	0.360**	2.368
	(-0.308)	(-0.758)	(-0.152)	
Fertilizer cost	1.93	2.01	0.0807	0.218
	(-0.172)	(-0.328)	(-0.371)	
Total variable cost	110.335	117.615	7.281***	3.526
	(-9.059)	(-17.904)	(-2.065)	
Cost of land	22.445	26.482	4.038***	3.795
	(-1.791)	(-3.648)	(-1.064)	
Cost of water-pump	9.528	15.059	5.531*	1.864
	(-2.465)	(-4.312)	(-2.967)	
Total fixed cost	31.972	41.541	9.569**	2.409
	(-3.208)	(-7.298)	(-3.972)	

Source: Computed from Field Survey, 2019, values in parentheses are standard errors; *Significant @ 10% level; **Significant 5% level; ***Significant @ 1% level

Table 3: Estimated Full Information Maximum Likelihood of the Endogenous Switching Regression

Variables	Selection equation	Non-participants ($i = 0$)	Participants ($i = 1$)
Constant	-0.928* (0.5466)	1.221*** (0.240)	2.232* (1.002)
ln(Hired labour cost)	4.970*** (1.500)	-2.448** (1.092)	-3.857*** (1.473)
ln(Fingerlings cost)	3.943*** (0.510)	-1.017*** (0 .084)	-1.526*** (0.408)
ln(Feed cost)	3.730*** (0.946)	-0.016** (1.007)	0.971** (0.505)
ln(Lime cost)	0.0047*** (0.0004)	-0.575** (0.232)	-1.174** (0.560)
ln(Fertilizer cost)	-0.0135*** (0.0005)	-1.736* (0.951)	1.590*** (0.236)
ln(Land cost)	-4.380** (0.207)	0.168*** (0.057)	0.515 (0.734)
ln(Wpump cost)	2.683*** (0.507)	-0.273*** (0.101)	0.485** (0.216)
ln(Farm size)	2.133*** (0.665)	1.021** (0.496)	0.409* (0.524)
Numb. Ponds	1.860*** (0.498)	0.005 (0.004)	-0.161*** (0.046)
Nfishstocked	2.624 (2.773)	-0.0004*** (0.0001)	-0.0003*** (0.0001)
ln(output)	1.133*** (0.666)	1.268 (0.454)	1.662 (0.310)
Age	-0.039*** (0.011)		
Household-size	-0.354*** (0.030)		
Years of Farming	0.142*** (0.012)		
Marketable surplus	2.991*** (0.287)		
Male	0.577** (0 .283)		
Married	0.602** (0.296)		
Educated	0.353** (0.175)		
σ_i		4.951*** (0.397)	1.213*** (0.055)
ρ_i		-0.275*** (0.100)	0.578*** (0.153)
Log-likelihood	-960.876***		
LR test of independent equation	10.29***		

Source: Authors' computation from Field Survey, 2019; *Significant @ 10% level; **Significant 5% level; ***Significant @ 1% level; Standard errors in parentheses. σ_i denote the square root of the variance of the error terms w_{1i} and w_{0i} in the outcome equations, respectively; ρ_i indicates the correlation coefficient between the error term of the selection equation and the error term of the outcome equations