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Exploring the Linkages between Rural Incomes and Non-farm Activities

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ABSTRACT

The present study aimed to establish the impact of non-farm participation on rural non-farm incomes using the PSLM-HIES 2007-2008 data. Heckman Procedure was employed to examine the effects of non-farm activities on agricultural incomes and to analyze the counterfactual income scenarios. Results revealed that access to non-farm income sources led to an increase in rural income by providing alternatives to households with lower agricultural productivity; moreover, non-farm activities had positive spill-over effects on agricultural productivity. Education, household landownership and participation of local population in non-farm activities were all found to be significant determinants of participation in non-farm activities. Households that have specialized in farming were found to have unobservable characteristics that make them better farmers. © 2012 Friends Science Publishers

Key Words: Non-farm; Heckman procedure; Counterfactual income

INTRODUCTION

The rural population constitutes over 66% of the total population in Pakistan and relies mainly on agriculture for income generation. This sector has however, witnessed an unstable growth in the last eight years and its share of GDP has been constantly declining and stood at 21% in 2007-2008. In the absence of an alternative in the form of a robust non-farm income culture, the rural poor remain vulnerable to economic shocks resulting from market forces and vagaries of nature that impact directly on farm income.

The rural non-farm sector in Pakistan, as in other developing countries, is a heterogeneous sector covering a wide spectrum of activities. The pursuit of this diversification leads one to explore the potentials of the whole range of non-farm activities. The considerable body of literature on poverty in Pakistan has largely ignored the importance of non-farm sector in poverty alleviation. Only a few recent studies, based on relatively small sample size, have examined linkages between rural non-farm sector and poverty. For example, Adams and He (1995) examined sources of non-farm income inequality. Linkages between rural non-agriculture employment and poverty in Pakistan were analyzed by Arif *et al*. (2001).

In view of the growing importance of non-farm activities in the rural economy, this study is critical in establishing link between rural welfare and non-farm income and particularly in drawing policy recommendations for poverty alleviation in rural areas through enhancing the deeper determinants of non-farm sectors.

MATERIALS AND METHODS

To explore the linkages between farm income and non-farm activities, two income regimes were considered. In regime 0, households that earn their livelihood by farming activities but do not participate in non-farm activities were included. In regime 1, the households participated in both farm and nonfarm activities. Assuming logarithmic income model for regime 0:

$$logy_0 = E\ logy_0 = \beta_0 X_i + \gamma_0 \lambda_i + \mu_{i0}$$

Where X is the matrix of the observed characteristics of the household, λ_i is a function of observed characteristics and participation in nonfarm activities and μ_{i0} accounts for missing or unobserved characteristics. $E\ logy_0$ is the expected farm income in regime 0. The estimated expected log income is given by:

$$\hat{E} logy_{0i} = \hat{\beta}_0 X_i + \gamma_0 \lambda_i$$

Similarly, for regime1:

$$logy_{1i} = E\ logy_{1i} = \beta_1 X_i + \gamma_1 \lambda_i + \mu_{1i}$$

$$\hat{E} logy_{1i} = \hat{\beta}_1 X_i + \gamma_1 \lambda_i$$

The farm income earned by a household in both the regimes was obtained. Hence, for a household that participated in non-farm activities (P=1), the income obtained in regime 1 was the observable income that the household earned, while in regime 0 it was simulated. For households that did not participate in nonfarm activities,

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the farm income earned in regime 0 was the observable income, while income earned in regime 1 was simulated.

In this case, a self-selection bias arose due to the households' decision to participate in nonfarm activities. In regime 0, the farm income of households that relied purely on farming would not allow for a reliable estimate of what the households that had diversified into nonfarm would have earned had they stayed in farming only. Our sample, hence was nonrandom since households with characteristics better suited to farming had specialized in it; whereas, households lacking these (worse farmers) had diversified into non-farm activities. In regime 1, similarly, unobserved characteristics favoring diversification might have encouraged households to diversify in nonfarm activities. A pure farm household would likely earn less in regime 1 than the households already there.

Formally presenting the model in regime 0:

$$P_i^* = \alpha W_i + e$$
$$\begin{cases} P_i = 1 \; if P_i^* > 0 \\ P_i = 0 \; if P_i^* \leq 0 \end{cases}$$
$$log y_0 = E log y_o = \beta_0 X_i + \gamma_0 \lambda_i + \mu_{i0}$$

P_i representing the participation of a household in nonfarm activities is a binary variable equal to 1 if the household participates in nonfarm activities and 0 otherwise. W_i and X_i are the dependent variables of selection and substantive equations respectively with the error terms e and μ_{i0}.

The error terms $e \sim N(0,1)$ and $\mu_{i0} \sim N(0, \sigma^2)$ are assumed to be bivariate and normally distributed. The error terms e and μ_{i0} are independent of W and X respectively. The variance of e is assumed to be 1. The coefficient of correlation between e and μ_{i0} is $corr(e, \mu_1 i0) = \rho$.

Conditional on participation, expected value of farm income is:

$$E(\log y_{0i} | W_i, X_i) = \beta X_i + E(\mu_{0i} | X_i, W_i, e)$$

Since the participation on nonfarm activities does not depend on X_i and only on W_i and e and $\log y_{0i}$ is only observed when $P_i^* \leq 0$, the following inequality is obtained:

$$E(\log y_{0i} | W_i, X_i) = \beta X_i + E(\mu_{0i} | e > -\alpha W_i)$$

The conditional expected value of incidentally truncated bivariate distribution is inserted here:

$$E(\mu_{0i} | e > -\alpha W_i) = \rho_{e\mu} \sigma_\mu \lambda_i(-\alpha W_i)$$
$$E(\log y_{0i} | W_i, X_i) = \beta X_i + \rho_{e\mu} \sigma_\mu \lambda_i(-\alpha W_i)$$
$$E(\log y_{0i} | W_i, X_i) = \beta X_i + \beta_\lambda \lambda_i(-\alpha W_i)$$
$$log y_0 = E log y_o + + \mu_{i0} = \beta_0 X_i + \beta_\lambda \lambda_i(-\alpha W_i) + \mu_{i0}$$

Hence, a simple ordinary least square regression using only observed value would give biased estimates of βs omitting $\beta_\lambda \lambda_i(-\alpha W_i)$. Heckman (1979) has treated the specification bias as omitted variable problem, it follows an estimate for the omitted variable problem thereby corrects the specification error.

The coefficients obtained from the probit model are used to work out the marginal effects of the estimate. These are used to construct a selection bias control factor called Inverse Mill's Ratio. For this we need the term αW, the individual probability score calculated by summation of each variable is multiplied by its estimated probit coefficient:

$$\alpha W = w_1 \widehat{\alpha_1} + w_2 \widehat{\alpha_2} \ldots\ldots + w_k \widehat{\alpha_k}$$

The inverse mill's ratio is calculated for each case by dividing the normal density function evaluated at αW_i by the normal cumulative distribution function at αW_i.

"λ" ↓"i" " = E(" $e_{\downarrow}i$ |$P_{\downarrow}i$ ") = " {(("-Øα" "W" ↓"i")/"1-Φ" ("α" "W"

This factor is a summarizing measure which reflects the effects of all unmeasured characteristics which are related to participation in nonfarm activities.

The first stage of Heckman Two Stage Procedure is to compute inverse mill's ratio using a probit model of participation as shown above. In the second stage, the substantive equation is estimated using ordinary least squares regression; the explanatory variables include X_i and $\hat{\lambda}$ run only on the uncensored observations:

$$log y_0 = E \; log y_o = \beta_0 X_i + \gamma_0 \lambda_i + \mu_{i0}$$

The standard errors need to be corrected because the additional variance due to the inclusion of inverse mills ratio which is estimated with uncertainty. Secondly, if there is selection, then there is heteroskedasticity since there is truncation and lower variance in our sample.

The parameter identification problem occurs in multiple equation models, where equations have variables in common hence an exclusion restriction is required; in our model the exclusion restriction were the following variables: the participation of local workforce in non-farm activities, the gender of the head of household, the age of the head of household and the wealth index of the household.

The estimation of counterfactual income estimates was carried out using the predicted income equations with and without non-farm activities. Following De Janvry *et al.* (2005), household *i*'s, farm income in regime 0 was estimated. For households $P_i = 0$, this is the observed income given by:

$$log y_0 = \beta_0 X_i + \gamma_0 \lambda_i + \mu_{i0}$$

To estimate the counterfactual income for households $P_i = 1$ in scheme 0, the coefficients were estimated from 1931 households that do not participate in non-farm activities. Since selection bias is present, the estimated coefficient for inverse mills ratio was also used. These coefficients were applied to the 1446 households that had participated in non-farm activities to obtain the counterfactual income with control for selection bias. Thus

income in the absence non-farm activities was estimated for households $P_i = 0$ as well as $P_i = 1$:

$$\widehat{log}y_0 = \begin{cases} log y_0 = \beta_0 X_i + \gamma_0 \bar{z}_i + \mu_{i0} & for\ P_i = 0 \\ E\widehat{log}y_0 = \beta_0 X_i + \gamma_0 \bar{z}_i + \hat{\mu}_{i0} & for\ P_i = 1 \end{cases}$$

Similarly, for regime 1, the observed income of 1446 households participating in nonfarm activities was used to calculate the coefficients that were applied to the 1931 households to obtain a counterfactual income for households that have not diversified in nonfarm activities. Thus, the income in the presence of non-farm activities for households $P_i = 0$ and $P_i = 1$ was obtained.

$$\widehat{log}y_1 = \begin{cases} log y_1 = \beta_1 X_i + \gamma_1 \bar{z}_i + \mu_{i1} & for\ P_i = 1 \\ E\widehat{log}y_1 = \beta_1 X_i + \gamma_1 \bar{z}_i + \hat{\mu}_{i1} & for\ P_i = 0 \end{cases}$$

A set of two counterfactual incomes and two observed incomes was obtained allowing analysis of the linkages between farm income and non-farm activities.

This study used data from Household Integrated Economic Survey (HIES) conducted by Federal Bureau of Statistics in 2007-2008. It is a nationally representative survey used for the compilation of various official statistics. Table I gives the specification of the participation and income equations.

RESULTS AND DISCUSSION

Estimation of the participation equations: Table II presents the results of probit regression together with marginal probabilities. If the head of household was female, then the incidence of participation in non-farm activities strongly and significantly decreased, corroborating the findings of Arif *et al.* (2001). The marginal effects may be directly interpreted and show that probability of participating in nonfarm activities decreased by 19.36 percentage points. This may be due to both tradition taboos and social expectations that prevent women from seeking more formal employment and from women lacking the requisite skills for nonfarm employment. The age of the head of household was found to be statistically significant; the probability of participation decreased by 0.28 percentage points with each year. A quadratic relationship might be assumed to exist. The number of workers was positively related and statistically significant (at 7.1 percentage points); a higher number of workers leads to a lower land-to-worker ratio and may encourage participation via wealth effect (Islam, 1997; Lanjouw & Shariff, 2002). The number of dependents was also positively related (1.11 percentage points) since they supply the unpaid help for farming needed to relieve full-time workers.

The two variables regarding education, the mean years of education of the household and the number of literate persons in a household, revealed a strong positive relation with likelihood of participation in nonfarm activities. The presence of one more literate person in a household increased the chance of participation by 2.53% with t=6.47 whilst an extra year of mean education of the household increased the likelihood of participation by 4.27% with t=3.85. This supports the hypothesis that returns to education are higher for off-farm versus on-farm activities. These findings substantiated the conclusion "Education of other household members as well as the accumulated years of education is just as important as that of the head of household", drawn by Yunez-Naude and Taylor (2001).

There is complex interaction between the landholding of a household and the likelihood of nonfarm employment. The total landholding size –via wealth effect- was positively related to participation in nonfarm activities with an additional acre of land increasing the likelihood by 0.60967 percentage points with (t = 3.26***). The per capita landholding was found to be negatively related with each extra acre, decreasing the chances of participation with 5.48% (t = -4.45***); this variable captures the opportunity to participate in agriculture. An abundant labor supply and limited arable land remains one of the prime reasons for the households to diversify in other remunerative activities.

The participation of local workforce in nonfarm activities was very strongly related (t = 10.16) with the decision of a household to participate in nonfarm activities. If the nonfarm employment rate of peers increased by 10% then the chance of nonfarm employment increased by 5.5 percentage points. Hence, there were positive spillover effects across the local workforce, known as the peers' effect in securing non-farm employment. This is in agreement with the anecdotal evidence, which often suggests the role of referrals in securing a job or the value of information garnered from peers.

Estimation of the income equations: The inverse mills ratio gives the correlation between the residuals from the participation equation and from the farm income equation. If the unobservable characteristics from the participation equation are correlated to the unobservable characteristics in the income equation, there is selection bias (Table III). Since the selection equation was modeling participation in nonfarm activities, the inverse mills ratio was negative for households not participating in nonfarm activities and positive for P=1. In Regime 0, the negative rho and hence the coefficient indicated that the unobservable factors influencing the decision to participate were negatively related to the unobservable factors affecting the farm income; in other words, the factors that prompted the household to not participate in nonfarm activities also seem to influence the factors that lead to a higher farm income. The coefficient for the inverse mills ratio was statistically significant reflecting that these households had unobservable characteristics (greater ability, experience etc.) such that there was positive selection for these farm households to stay in agriculture and not

Table I: Specification of Variables

Variable	Description	Participation Equation	Regression Equation
Female	A dummy variable equal to 1 if the household is headed by a female and 0 otherwise.	Included.	
Head Age	The age of the head of household in years.	Included.	
Workers	The number of household members that are above age 10 and are employed or seeking employment.	Included.	Included.
Dependents	The household members that are not economically active nor are seeking employment.	Included.	Included.
No. of literate persons in a household	The number of household members that can read and write in at least one language.	Included.	Included.
Mean Years of education of Household Members	The mean years of education of the workers in the household.	Included.	
Land Owned Sum	The total landholding of the household. (In Acres)	Included.	Included.
Operational Farm Area	The total farm area that is operational. (In Acres)	Included.	Included.
Irrigated Sum Farm	The total farm area that is irrigated. (In Acres)	Included.	Included.
Land Area Squared	The total farm area squared in acres.		Included.
Per Capita Land	The per capita landholding of the household is obtained by dividing the total land owned in acres by the number of household members.	Included.	Included.
Livestock Participation	A dummy variable equal to 1 if the household participates in livestock rearing and 0 otherwise.	Included.	Included.
PSU literacy Rate	The percentage of adults who are literate in the primary sampling unit.	Included.	
Zone 1	A dummy variable equal to 1 if the zone is Rice/Wheat Punjab. The reference zone is Balochistan.	Included.	Included.
Zone 2	A dummy variable equal to 1 if the zone is Mixed Punjab.	Included.	Included.
Zone 3	A dummy variable equal to 1 if the zone is Cotton/Wheat Punjab.	Included.	Included.
Zone 4	A dummy variable equal to 1 if the zone is Low Intensity Punjab.	Included.	Included.
Zone 5	A dummy variable equal to 1 if the zone is Barani Punjab.	Included.	Included.
Zone 6	A dummy variable equal to 1 if the zone is Cotton/Wheat Sindh.	Included.	Included.
Zone 7	A dummy variable equal to 1 if the zone is Rice Other Sindh.	Included.	Included.
Zone 8	A dummy variable equal to 1 if the zone is Khyber Pukhtunkhwa.	Included.	Included.
Participation of Local Workforce in RNF activities	The percentage of workforce that is employed in nonfarm activities in a PSU.	Included.	

Table II: Probit Estimation of the Participation Equation

Dependent Variable = 1 if household participates in Nonfarm Activities			
Independent Variables	**Coefficient**	**dF/dx**	**z statistic**
Female	-0.54806	-0.1940942	(-4.24)***
Head Age	-0.00674	-0.0026265	(-3.64)***
Workers	0.182594	0.0711763	(11.53)***
Dependents	0.028389	0.011066	(2.95)***
No. of literate persons in a household	0.063322	0.0246832	(3.85)***
Mean Years of education of Household Members	0.109312	0.0426104	(6.47)***
PSU literacy Rate	-0.30091	-0.1172976	(-1.69)*
Land Owned Sum	0.015567	0.006068	(3.26)***
Operational Farm Area Owned	0.002736	0.0010666	(0.89)
Irrigated Sum Farm	-0.02253	-0.008783	(-7.02)***
Per Capita Land	-0.13938	-0.0543327	(-4.45)***
Wealth Index	3.54E-07	1.38E-07	(2.12)**
Livestock Participation	-0.48458	-0.1911468	(-7.06)***
Zone 1	0.457102	0.1806773	(-3.49)***
Zone 2	0.279909	0.1107564	(2.32)**
Zone 3	0.49449	0.1951938	(4.65)***
Zone 4	0.408599	0.1617177	(3.49)***
Zone 5	0.63842	0.2498348	(4.41)***
Zone 6	0.166946	0.0657849	(1.33)
Zone 7	0.250236	0.0988734	(2.31)**
Zone 8	0.867258	0.3352375	(9.07)***
Participation of Local Workforce in Nonfarm Activities	1.388144	0.5411087	(10.16)***
Constant	-1.39106		(-9.17)***
Number of Observations	3377		
Log Likelihood	-1.16832		
Pseudo R squared	0.1811		
LR chi2(22)	835.3		
Prob> chi2	0		

(*) dF/dx is for discrete change of dummy variable from 0 to 1
z and P>|z| correspond to the test of the underlying coefficient being 0

diversify in nonfarm sector. These households had higher farm income than an average household would have had in this regime. The coefficient for IMR was not statistically significant for regime 1 indicating a random selection of households in this regime.

The number of workers was found to be positively related and statistically significant (t=2.65) in regime 1, whilst this was not the case for regime 0. This may be due to underemployment of household labor in regime 0 given that there is no diversification in nonfarm activities. The number of literate adults was found to be statistically significant for both the regimes. The effects were greater for Regime 1. The findings are similar to Anriquez and Valdes (2006) who found in Pakistan that the returns to education are high, particularly, for medium and large sized farms.

Land owned was found to be positively related to the farm income and to be statistically significant in both the regimes. The square of this term was, however, negatively related (though statistically significant) reflecting a quadratic relation. Given the magnitude of these coefficients, the farm income does not start decreasing until the land owned does not reach a value well beyond the average farm size. It may be assumed that farm income and size are positively related. These results are similar to Anriquez and Valdes (2006) and Satriawan and Swinton (2005).

The counterfactual and observed incomes in both regimes 1 and 0 following the procedure outlined above have been presented in Table IV. The farm income of households that had diversified into non-farm activities would have been Rs. 39,447 in the event of their non-participation, which is lesser than the farm income of the households that had stayed in agriculture (Rs. 99,681). It can be seen that the farmers that had stayed in agriculture (P=0) are better farmers than those that had diversified in nonfarm sector (P=1) earning an additional income of Rs. 60,235. Were these households (P=0) to diversify into nonfarm sectors, their farm incomes would have increased to Rs. 147,572, which is again more than the mixed farming households (Rs. 71,186). Hence, the households, P=0, emerge as winner in both the regimes.

A far as linkages between farm income and non-farm activities are concerned, it is evident that the farm income for both the group of participants and nonparticipants was higher in Regime 1 compared to Regime 0. For the group of participants (P=1), the farm income increased from Rs. 39,447.05 to Rs. 71,186.07 by participation in non-farm activities. For pure farm households, P=0, the farm income the increase was by 48% from Rs. 99681.72 (observed) to Rs. 147,572.20 (simulated).That participation in nonfarm activities increases the productivity of agriculture seems evident.

Table III: OLS Estimation of the Farm Income Equation

	Regression2 Regime 1			Regression 3 Regime 0		
Explanatory Variable	**Coefficients**	**t statistic**	**P>|t|**	**Coefficients**	**t statistic**	**P>|t|**
Workers	0.11004	2.65	0.008	0.029471	0.86	0.39
Dependents	-0.0215	-1.12	0.263	0.012763	0.75	0.452
No. of Literate Persons in a Household	0.13164	3.88	0	0.076012	2.35	0.019
Land Owned Sum	0.04252	2.75	0.006	0.036424	4.12	0
Livestock Participation	0.21139	1.15	0.25	0.196683	1.37	0.172
Operational Farm Area	-0.0228	-3.41	0.001	-0.01361	-1.77	0.077
Irrigated Sum Farm	0.02729	3.08	0.002	0.019734	2.79	0.005
Per Capita Land	-0.0245	-0.28	0.781	-0.02699	-1.02	0.31
Land Owned Squared	-2E-05	-3.07	0.002	-2.30E-05	-4.08	0
Zone 1	-0.0358	-0.12	0.903	-0.16507	-0.84	0.399
Zone 2	-0.3052	-0.96	0.335	-0.42325	-2.17	0.03
Zone 3	-0.67	-2.28	0.023	-0.88425	-4.82	0
Zone 4	-0.2306	-0.73	0.463	-0.7388	-3.86	0
Zone 5	-0.9527	-2.88	0.004	-0.83626	-3.12	0.002
Zone 6	0.27417	0.93	0.35	0.251681	1.42	0.156
Zone 7	0.52554	1.79	0.073	0.164428	0.94	0.347
Zone 8	-0.853	-3	0.003	-1.10621	-5.54	0
Constant	9.46417	22.61	0	10.20136	52.77	0
Inverse Mills Ratio	0.05599	0.2	0.842	-0.463814	-1.96	0.05
Rho	0.02546			0.24762		
Sigma	2.1994			1.873115		
R Squared	0.1349			0.1267		

Table IV: Farm Incomes in Regime 0 and Regime 1

	Regime 0 : Households Not Participating in Nonfarm Activities	**Regime 1: Households Participating in Nonfarm Activities**
Households Not Participating in Non-Farm Activities	Rs. 99681.72 (Observed)	Rs. 147,572.20 (Simulated)
Households Participating in Non-Farm Activities	Rs. 39,447.05 (Simulated)	Rs. 71,186.07 (Observed)

CONCLUSION

Participation in the nonfarm sector has a very important contribution towards increasing the absolute income of mixed farmers. Income diversification is hence crucial for sustaining livelihoods, therefore policies and projects should aim at lowering entry barriers for participation in the non-farm sector.

The rural population is prevented from participating in non-farm sector by entry barriers that demand a higher level of education, it was noted that the level of education and number of literate people in the households both showed a strong positive correlation with RNF participation. It was also seen that the pay offs of education were greater for non-farm households than for farming ones. In order to increase RNF participation, special focus should be paid to raising the literacy rate and the education levels of the rural population through the setting up schools and vocational centers.

Access to credit is also one of the major obstacles to non- farm participation. A study of community variables reveals that physical infrastructure like village electrification also improves chances of participation, therefore initiatives to improve rural infrastructure like rural electrification and the building of roads would also prove helpful. Participation of women can be increased by promoting non-farm industries that offer convenient employment such as cottage industries. Training workshops and skill enhancing programs should target capacity building of females.

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