Determinants of Household Income: A Quantile Regression Approach for Four Rice-Producing Areas in the Philippines

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ABSTRACT

This paper investigates the determinants of total household income in selected rice-based farming villages in the Philippines. A quantile regression approach was applied on cross-section data obtained from 656 farming households across four provinces. Determinants of household income were examined using an ordinary quantile regression approach, which, unlike conditional mean regression, allows parameter variation across income quantiles. The quantile regression approach also enables the analysis of income determinants for extreme categories such as low-income households. Results indicate that coefficients estimated through ordinary least squares (OLS) could be misleading. The quantile estimates preserved their signs in most cases but their magnitude varied across quantiles. The paper particularly emphasizes the determinants of income for poor households. The quantile estimations show that education of the male head and the existence of migrant workers in households are the most important determinants of income for poor households.

Keywords: household income, rice farming, quantile regression
JEL classification: J1, Q1, R2, D13, D24

INTRODUCTION

The population of the Philippines in 2007 was approximately 88.5 million, according to the census conducted that year by the National Statistics Office (NSO). The population growth rate for the period 2000–2007 was 2.04 percent (NSO 2012). Using these figures, the NSO has projected the population to be 94.01 million in 2010. This continued population growth requires more production and an increased labor force in the domestic agriculture. In 2011, agriculture's share in the gross domestic product (GDP) was 12.3 percent, substantially lower than the share of the industry and services sectors at 33.3 percent and 54.4 percent, respectively (Central Intelligence Agency [CIA] 2012). Pasadilla and Liao (2006) note that, even though the Philippines has not been a major exporter of agricultural products, agriculture remains important for the economy because it accounts for 37 percent of the labor force.

Rice is the most important food crop because it is the staple food in most of the country. It is produced extensively in Luzon, Western Visayas, Southern Mindanao, and Central Mindanao. In 2010, nearly 15.7 million metric tons of palay were produced (Bureau of Agricultural Statistics [BAS] 2010). Moreover, palay accounted for 21.86 percent of the gross value added in agriculture and 2.37 percent of the gross national product (National Statistics Coordinating Board [NSCB] 2010). As such, rice income is important in the Philippines. Since the mid-1960s, rice yields have increased substantially as a result of the cultivation of high-yielding varieties developed at the International Rice Research Institute (IRRI). Still, yields have been generally low compared with those of other Asian countries. Of the 4.3 million hectares of harvested area planted to rice in the Philippines, 69 percent are irrigated and the rest are rainfed (BAS 2010).

The importance of rice in total household income varies because of several factors, one of which is availability of assured irrigation. In the past few years, several studies had examined the importance of rice in total household income of rice-farming households in Asia, including the Philippines (David and Otsuka 1994; Hossain, Gascon, and Marciano 2000; Dawe, Moya, and Casiwan 2006; Pandey, Paris, and Bhandari 2010). The economic well-being of rural households was found to depend only partially on rice cultivation and additionally on what happens with other sources of income. Like most other Asian countries, a Filipino farm household is a multi-occupation entity; rice income accounts for only a fraction of its total income. These studies have categorized the major sources of household income into farm, off-farm, and non-farm sources. Farm income is earnings from crops grown in farmers' fields, animal production, rents of farm durables, and by-products of crops and animals. Off-farm income is wages received by working on other farms either in the farmer's own village or in neighboring villages. Non-farm income sources include all income from wages earned from business and other non-farm activities, pensions, and remittances.

A previous rice village study in the Philippines by Hayami and Kikuchi (2000) compared the changing trend in sources of rural household income, particularly income from rice production. The overall contribution of rice to total household income steadily declined from 51 percent to 18 percent and to 14 percent in the 1970s, 1980s, and 1990s, respectively. This is partially explained by the fact that rural residents gradually received more employment from non-farm sources as a result of human capital development. A study by Otsuka, Cordova, and David (1992) showed that non-farm activities had increased during the post–Green Revolution period as a result of improved agricultural technology and human capital development. However, past studies failed to differentiate between the determinants of household income for poor households and richer ones. The assumption has often been that the factors determining income are the same for the entire distribution of households. This may not always hold. Indeed, the determinants of household income are unlikely to be the same because large differences could be observed across quantiles in terms of socioeconomic characteristics and resource endowments. For instance, the lower quantile of income distribution, representing the poor, is often characterized by lower resource endowment and less access to productive resources. Allowing parameter variation in the determinants of income in different quantiles of income distribution has methodological and policy relevance. Compared with the traditionally used conditional mean regression, quantile estimation can more appropriately account for extreme values and outliers in the distribution (Hao and Naiman 2007). From the policy point of view, knowing the determinants of total household income for poorer households can lead to the development of group-specific poverty reduction policies.

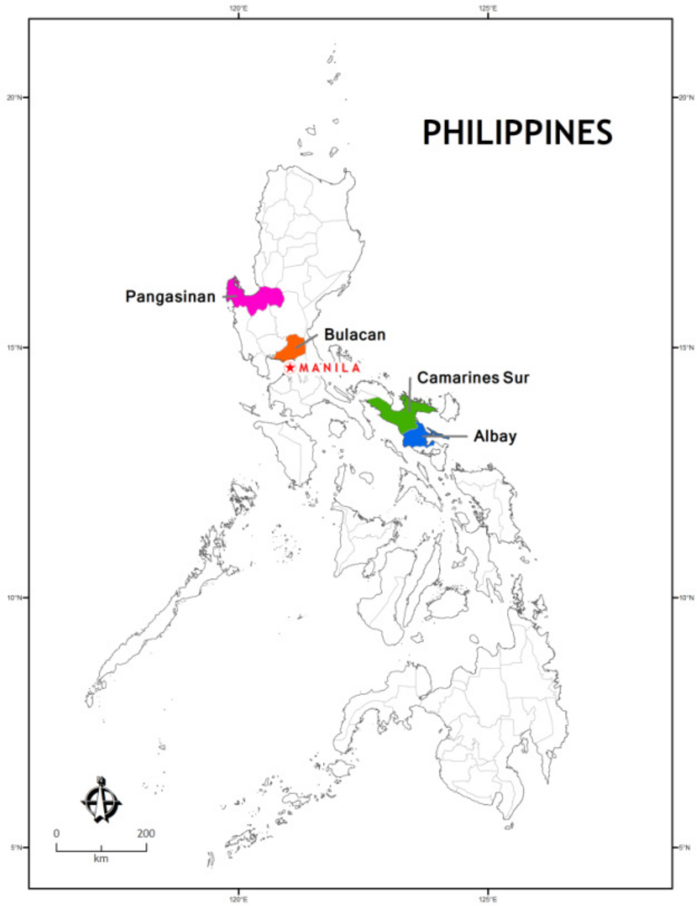
Numerous studies have investigated the determinants of household income in farming areas using the conditional mean approach (see for instance Estudillo, Sawada, and Otsuka 2009; Kajisa and Palanichamy 2006; Onyebinama and Onyejelem 2010). Given the diversity of income sources available to the various households, trying to explain the determinants of overall household income poses several problems. First, given that the sources of income are extremely diverse and complex, using a few household characteristics may not sufficiently explain the overall income variability and could lead to an "omitted variables" problem, which biases the estimates. Second, there is no clear theoretical guidance as to which variables should be included in the income model. The factors that are relevant in explaining the income of the poor may not be the same for the rest of the distribution.

This paper argues that it is more meaningful and relevant to investigate income determinants at different points of the income distribution rather than covering the entire distribution. It posits that the factors determining household income may vary in sign and magnitude at different points of the income distribution. In particular, lower income quantiles (representing the poor) are expected to behave differently due to variations in farming and socioeconomic characteristics. This study therefore considered a simultaneous quantile regression divided at the 5th, 10th, 25th, 50th, and 75th quantile level. These results were compared with those of the traditional OLS estimation and an interquantile regression was carried out between the 25th and 75th quantiles to investigate the significance of the difference among quantile coefficients. This approach was applied to data from 656 rice farming households from four provinces in northern Philippines: Pangasinan, Bulacan, Camarines Sur, and Albay (Figure 1).

METHODOLOGY

The determinants of household income were estimated following a quantile regression approach. The quantile approach has the advantage of allowing parameter variation across quantiles of the income distribution. Previous studies used the traditional linear regression approach, particularly ordinary least squares (OLS), to investigate household income determinants (Estudillo, Sawada, and Otsuka 2009; Kajisa and Palanichamy 2006; Onyebinama and Onyejelem 2010). This approach simply estimates the conditional mean of the response variable (household income) given a set of explanatory variables. The resulting coefficients are the marginal

Figure 1. Map of the Philippines and research sites



effects of the corresponding variables at the conditional mean. More explicitly, the estimated coefficients in the regression mean approach represent the average change in the response variable associated with a change in the related explanatory variable. In this regard, the regression mean approach may not be appropriate in explicitly dealing with extreme values and outliers in the distribution of the dependent variable. For instance, groups of interest such as the lower income quantile representing the poor may be overlooked. The quantile regression approach can suitably address such situation because it can investigate income determinants for specific quantiles of the income distribution.

The advantages of quantile regression over OLS regression have been explicitly discussed in the economic literature. The estimated coefficients of the quantile regression are not sensitive to outliers of the dependent variable, and the quantile estimator is more efficient than OLS when errors are not normally distributed (see Buchinsky 1998). The quantile regression approach also enables researchers to pre-define any positions of the distribution according to their specific inquiries (see Hao and Naiman 2007).

Following the specification of the quantile regression as presented by Koenker and Basset (1978), consider (y_i, x_i) $i = 1,......, N$ a sample derived from a population, where x_i is a $K \times 1$ vector of regressors representing the determinants of household income and y_i is a random sample representing the dependent variable such that:

$$y_i = x_i\beta + \varepsilon_i \quad (1)$$

where ε_1 represents the disturbance term and β the unknown parameters.

The quantile regression for a given quantile $\theta \in]0,1[$ is obtained from the minimization of the objective function F over β_θ.

$$F = \sum_{i\in\{i:y_i\geq x_i'\beta_\theta\}} \theta\left|y_i - x_i'\beta_\theta\right| + \sum_{i\in\{i:y_i<x_i'\beta_\theta\}} (1-\theta)\left|y_i - x_i'\beta_\theta\right| \quad (2)$$

When $\theta=0.5$, the quantile regression is simply the median regression. The study considered bootstrap standard errors on the estimated parameters with 100 replications. Table 1 shows the independent variables included in the model. An interquantile regression was also carried out by taking the difference of coefficients from the 75th to 25th quantiles.

DATA

This study was conducted in four rice-producing provinces of the Philippines. These provinces were selected after consultations with the Philippine Department of Agriculture offices at both the national and provincial levels. A consideration for selecting the provinces was the type of rice production system the farmers were using. Pangasinan and Bulacan represented the rainfed rice production system and Camarines Sur and Albay represented the irrigated production system. The two rainfed provinces are near urban areas and could therefore be considered peri-urban areas, while the provinces with irrigated systems are rural areas. A total of 656 farming households were randomly interviewed in 2005 using a structured questionnaire. Values for total household

Table 1. Definition of determinants of total household income

Variable	Name	Definition
x_1	Peri-urban	Dummy variable for village classification (1 - peri-urban; 0 - strictly rural)
x_2	Irrigation	Dummy variable for production system (1 - irrigation; 0 - rainfed)
x_3	Migrant	Dummy variable for migrant remitter (1 - migrant; 0 - none)
x_4	Household type	Dummy variable for household type (1 - absolute nuclear; 0 - other)
x_5	Farm size	Size of total farm landholdings in hectares
x_6	Age	Age of husband in years
x_7	Education	Education level of husband in years
x_8	Own farm	Dummy variable for tenure status (1 - owner; 0 - non-owner)
x_9	Household size	Total number of residents living in the house
x_{10}	Machine	Dummy variable for machine (1 - owner; 0 - non-owner)
x_{11}	Small livestock	Dummy variable for small livestock ownership (1 - owner; 0 - non-owner)
x_{12}	Large livestock	Dummy variable for large livestock ownership (1 - owner; 0 - non-owner)
x_{13}	Carabao	Dummy variable for carabao ownership (1 - owner; 0 - non-owner)
x_{14}	Multiple cropping	Dummy variable for number of seasons grown (1 - multiple; 0 - single)

income were deflated using the consumer price index (CPI). The deflators used differed for each province due to differences in location and time (i.e., the surveys were conducted at different times). All values of total household income were converted into year 2000 Philippine Pesos (PHP).[1]

The respondents' socioeconomic and farm characteristics are presented in Table 2. In addition to the pooled sample of the data, results for the 25th, 50th, and 75th quantiles are shown. The sample was divided into quarters, based on total household income; the results of the top and bottom quarters were compared. The comparison yielded some interesting differences. For instance, more farmers in the top quarter owned their farms and were better educated; their land size was more than double that of the bottom farmers. Surprisingly, the top quarter had fewer farmers using an irrigated production system and had a slightly bigger average household size (by more than one person) than the bottom quarter. The data also show that as their household income increased, the farmers chose to replace the carabao with machines. One of the most

Table 2. Descriptive farm and socioeconomic characteristics for pooled, quantiles, and top and bottom quarters

Variable	Quarter		Pooled	Quantile		
	Bottom (n=164)	Top (n=164)	(n=656)	25th (n=164)	50th (n=328)	75th (n=492)
Village location (%)						
Peri-urban	20.70	13.40	16.60	20.70	18.30	17.70
Strictly rural	79.30	86.60	83.40	79.30	81.70	82.30
Production system (%)						
Irrigated	55.50	44.50	49.20	55.50	53.70	50.80
Rainfed	44.50	55.50	50.80	44.50	46.30	49.20
Type of household (%)						
Absolute nuclear	76.80	67.10	71.30	76.80	72.30	72.80
Joint	23.20	32.90	28.70	23.20	27.70	27.20
Farm tenure (%)						
Owner	57.90	73.20	65.50	57.90	60.40	63.00
Non-owner	42.10	26.80	34.50	42.10	39.60	37.00
Farm size (ha)	0.85	1.76	1.34	0.85	1.09	1.20
Husband age (yr)	54.48	55.52	55.11	54.48	54.82	54.97
Husband farm experience (yr)	24.72	25.35	25.16	24.72	25.49	25.10
Husband education (yr)	7.66	9.04	8.30	7.66	7.77	8.05
Wife education (yr)	7.66	9.07	8.41	7.66	7.86	8.19
Size of household	5.21	6.31	5.77	5.21	5.47	5.60
Machine ownership (%)	30.50	54.30	45.60	30.50	39.00	42.70
Carabao ownership (%)	24.40	18.90	23.90	24.40	25.90	25.60
Receiving remittance (%)	20.10	71.30	48.00	20.10	30.50	40.20
Total household income (PHP)	16,625	209,612	93,357	16,625	32,585	54,606

1 CPI data are from the National Statistics Office available at http://www.census.gov.ph/data/sectordata/datacpi.html

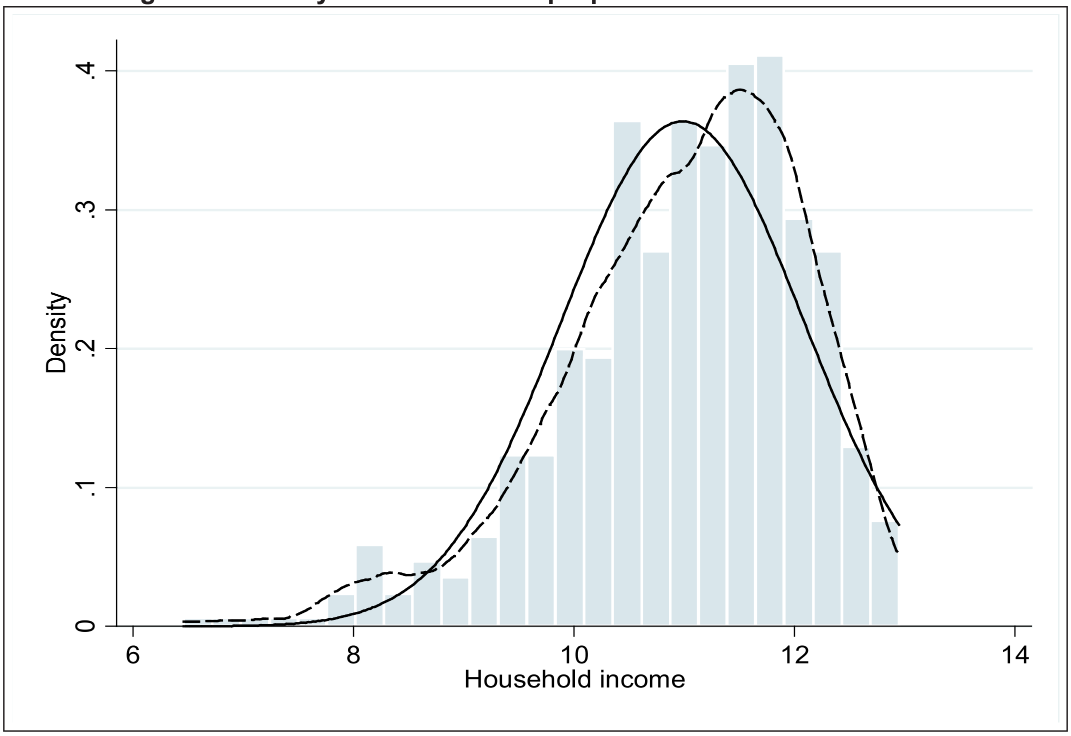
interesting results can be seen in remittances. Only 20 percent of the poorer households were receiving remittances from a migrant worker whereas 71 percent of their richer counterparts did. It may be because households with higher incomes have a higher capacity to finance the migration requirements of household members who apply for work overseas. Since the average age of household heads was around 55 years, the remittances were likely coming from their children who, having received better education, were able to find work outside their villages. Lastly, the difference in total household income is staggering: PHP 192,986.68.[2]

Figure 2 shows the histogram, kernel density estimation, and normal distribution. The histogram displays the density of respondents within the class or range of income (y axis). It presents the general shape of the income distribution, which appears to be normal, unimodal, and slightly skewed to the right. The kernel density estimation, on the other hand, smooths out the contribution of each observed data point over a local neighborhood of that data point.

RESULTS

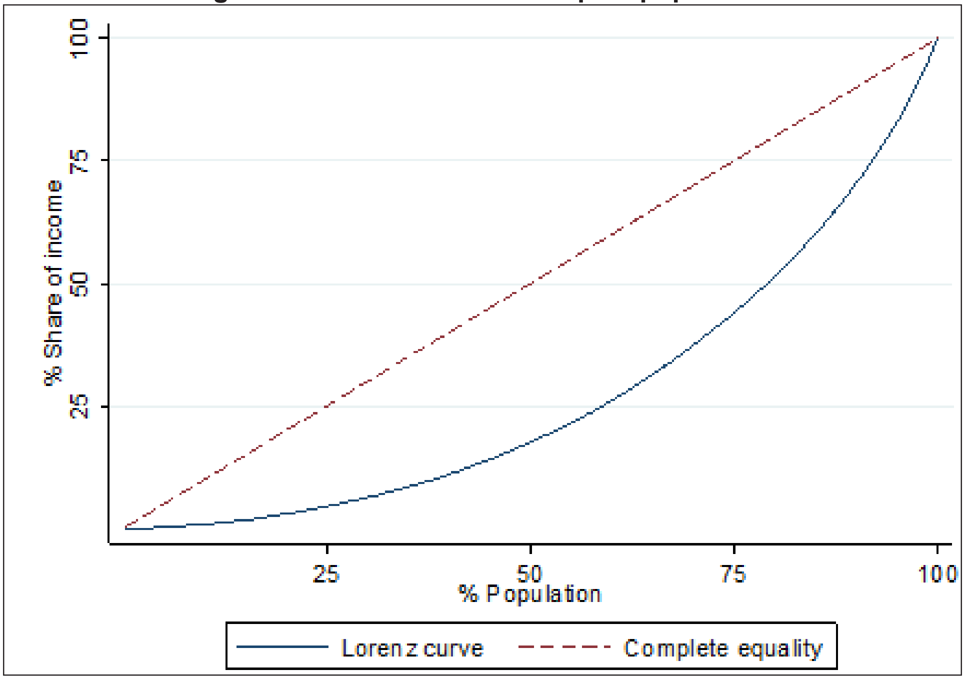
Figure 3 shows the distribution of income through the population of this sample. This study used a Lorenz curve to display the share of income at different levels of the population, presented as the solid line. The broken line in Figure 3 indicates how the income distribution would look in a completely equal society. It is a line at 45 degrees, with each proportion of the population having an equal portion of the income. When calculated according to quartiles of the population, the income shares were 4.48 percent, 17.53 percent, and 43.98 percent at the 25th, 50th, and 75th quartiles, respectively.

Figure 2. Density distribution and proportion of household income



2 The exchange rate in 2004 was USD 1 = PHP 56.04.

Figure 3. Lorenz curve for sampled population



These results mean that the lowest quartile (the poorest) accounted for less than 5 percent of the population's income while the top quartile (the richest) had over 50 percent of the income. (It is emphasized that these results are inclusive for the sample of this survey only and are not reflective of non-agricultural households in the same areas.) The large differences in income levels underscore the importance of using a simultaneous quantile regression rather than a mean regression.

Table 3 presents the estimation results. The first column contains the OLS regression estimates; the following columns show estimates of the 5th, 10th, 25th, 50th, and 75th quantiles, respectively. A comparison of the OLS estimates and those from the quantile regression shows that the latter's estimated coefficients retained their signs but their magnitude differed across quantiles. In some cases, a sign switch is noticed between the OLS and quantile regression estimates for some variables. The OLS results indicate that rice farmers who lived near urban areas had less income than those in rural areas. A similar result, but with a higher magnitude, is observed in the 5 percent quantile. Given that the income data had been adjusted for living cost in urban and rural areas, this difference could be related to agronomic and management practices. For instance, wage laborers in villages near urban areas had several alternatives in terms of income-generating activities; therefore, the farmer cultivators faced the risk of labor shortage, which could delay crop establishment activities or cause them to pay a higher wage rate. Also, farmers living in villages near urban areas were more likely to have more off-farm activities and therefore may spend less time on farming and crop management than farmers living far from the cities. This income difference between farmers near and far from cities could be due to the data considered. Indeed, Table 2 shows that the majority (83.4%) of farmers in the sample lived in rural areas.

The bottom quartile was largely composed of rural farmers, and they had more irrigated land areas. The OLS results indicate no significant

Table 3. OLS, quantile regression, and interquantile regression estimates

Variable	OLS	Quantile regression					
		5th	10th	25th	50th	75th	25th-75th†
Constant	8.553***	7.937***	7.843***	7.310***	9.086***	9.127***	1.8167
	−0.8261	*−2.1139*	*−1.6309*	*−1.3312*	*−1.2068*	*−1.1067*	*−1.3337*
Peri−urban	−0.189*	−0.553*	−0.315	−0.228	−0.074	−0.156	0.072
	−0.1017	*−0.309*	*−0.2475*	*−0.1705*	*−0.1464*	*−0.1284*	*−0.1446*
Irrigation	−0.21	−0.643**	−0.465**	−0.279	−0.065	−0.179	0.101
	−0.148	*−0.2996*	*−0.1916*	*−0.2377*	*−0.16*	*−0.1279*	*−0.223*
Migrant	0.786***	0.897***	0.969***	0.988***	0.796***	0.616***	−0.371***
	−0.0745	*−0.2115*	*−0.1292*	*−0.0989*	*−0.1295*	*−0.114*	*−0.1423*
Household type	−0.049	−0.650***	−0.214	−0.023	0.033	0.127	0.15
	−0.0859	*−0.1722*	*−0.1567*	*−0.1396*	*−0.1192*	*−0.1289*	*−0.1547*
Farm size	0.523***	0.600***	0.591***	0.608***	0.483***	0.429***	−0.179**
	−0.0527	*−0.1234*	*−0.1011*	*−0.0658*	*−0.0627*	*−0.0605*	*−0.0755*
Age	0.215	−0.095	0.062	0.32	0.104	0.224	−0.096
	−0.1795	*−0.4551*	*−0.3024*	*−0.2607*	*−0.2255*	*−0.2313*	*−0.2513*
Education	0.389***	0.659**	0.564**	0.439**	0.323**	0.326**	−0.113
	−0.0821	*−0.2651*	*−0.285*	*−0.1728*	*−0.1611*	*−0.128*	*−0.1715*
Own farm	0.249***	0.506**	0.367**	0.270*	0.189*	0.236**	−0.034
	−0.0741	*−0.2173*	*−0.1606*	*−0.143*	*−0.1143*	*−0.0925*	*−0.1294*
Household size	0.147	0.139	0.085	0.185	0.166	0.238	0.054
	−0.098	*−0.1868*	*−0.1439*	*−0.1747*	*−0.1385*	*−0.1517*	*−0.176*
Machine	0.083	0.207	0.162	0.034	0.188*	0.035	0.001
	−0.0779	*−0.1702*	*−0.1224*	*−0.1032*	*−0.0967*	*−0.0845*	*−0.0966*
Small livestock	0.123*	−0.047	0.044	0.128	0.103	0.068	−0.06
	−0.0717	*−0.1726*	*−0.1605*	*−0.1251*	*−0.0967*	*−0.1246*	*−0.1173*
Large livestock	0.086	0.515**	0.305**	0.102	−0.003	−0.108	−0.210*
	−0.0898	*−0.2062*	*−0.1415*	*−0.1448*	*−0.0959*	*−0.0829*	*−0.116*
Carabao	−0.277***	−0.523*	−0.449***	−0.398*	−0.185	−0.003	0.395***
	−0.0981	*−0.2899*	*−0.1222*	*−0.2086*	*−0.1615*	*−0.1225*	*−0.1502*
Multiple cropping	0.167	0.547**	0.249	0.25	0.06	0.166	−0.084
	−0.1423	*−0.2704*	*−0.1905*	*−0.194*	*−0.1118*	*−0.1252*	*−0.2567*
Pseudo R^2	0.3556	0.328	0.2964	0.2457	0.2009	0.1527	

Note: Standard errors of parameter estimates are in italics
***, **, and * refer to significance at the 1%, 5%, and 10% level, respectively

OLS estimation is R^2 and quantile regressions are Pseudo R^2

† is an interquantile regression

differences in income for irrigated and rainfed areas. On the other hand, results of the lower quantiles (5% and 10%) show that farmers in irrigated areas had less income. Although this finding may appear counter intuitive, there are plausible reasons for it. Farmers in rainfed conditions tended to diversify the crops they grew in a given year while farmers in irrigated areas tended to plant rice only throughout the year. Also, farmers did not have diesel fuel for irrigation as a farm input and therefore their production cost may have been lower.

In both OLS and quantile regressions, households with migrant workers had more income than those without. Interestingly, the magnitude of the coefficients on "migrants" is much higher in the lower quantiles than in the OLS estimate. In both cases, however, the coefficient for "migrants" has a higher magnitude than the other factors. The interquantile regression on the 25th and 75th quantiles indicates a significant difference between the coefficients of these two quartiles. Among the poor (5% quantile), absolute nuclear households had less income than the other household categories. Extended households had several family members contributing to the total household income. Having one or two members working overseas can contribute to a higher income.

As expected, landholding has a positive and significant effect on household income. This implies that having a large farm size contributes to higher household income because more cash crops may be produced or more land may be used as collateral for other income-generating materials/equipment or the placement fee for migration activity.

Education also contributes significantly to household income. Educated farmers are more likely to adopt new varieties and new farming technologies, which help increase their productivity and income. Also, being more educated offers opportunities for farmers to diversify and have other sources of income such as off-farm activities. In this study, the magnitude of contribution of education is higher among the poor. This denotes the importance of education in lifting rice farmers from poverty.

With regard to land tenure, results show that rice farmers owning land had higher income on average than those who did not. Farmers with land titles have a greater incentive to invest in their land and in turn receive higher returns on their investments. Moreover, land ownership offers farmers more flexibility to diversify. In particular, diversification contributes quite significantly to the income of poor rice farmers. A similar finding is observed for ownership of small livestock. Farmers raising small livestock had higher income than those who did not. However, contrary to expectations, farmers owning carabao had less income than those who did not. It is noted that a typical household has one carabao used for draft power. Thus, having one does not necessarily lead to higher income. The carabao is sold when cash is badly needed for large expenditures and during emergencies. In contrast, raising small livestock, particularly swine, is a common practice by women, serving as an independent source of income. Income from sales of small livestock, which occur several times within a year, is used to support the children's education and celebration of special occasions such as weddings as well as to buy farm inputs, pay debts, and purchase food and other daily expenditures.

CONCLUSION

This study investigated the determinants of household income in rice-farming villages in the Philippines using a quantile regression approach, which allows parameters to vary across income groups. Cross-section data from 656 farming households across four provinces were used. Results show that estimates for conditional mean regression with OLS could be misleading. Although most of the parameters estimated through OLS maintained their signs, the magnitudes of contribution varied depending on the quantile being considered. This study was particularly interested in investigating the main factors that determine income of the lower quantiles representing poor rice-farming households, which the quantile regression approach allowed to do. Results indicate that location (near urban area or strictly rural), irrigation, having a migrant member, household type (absolute nuclear or not), farm size, education, tenure (owning farm or not), raising small livestock, owning a carabao, and crop diversification are the main determinants of household income. Among these factors, education and having a migrant worker are the most important ones based on the magnitude of their estimated coefficients. This implies that education pushes educated adult members to migrate and look for better opportunities off-farm and send back remittances to the family left behind. Farmers left behind invest a portion of the remittances in farm inputs, leading to increased household income. Thus, they should be given adequate knowledge and skills in investing remittances in agriculture and other agri-based microenterprises.

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APPENDIX 1. COMPUTATION OF NET FARM INCOME

Gross rice income is equal to total production in kilograms (kg) multiplied by the current farm price per kg. The rice production costs are in Philippine pesos and comprise material, labor, source of power, fuel, and fees. Material costs consist of seeds, fertilizers, insecticides, herbicides, fungicides, and molluscicide; labor costs include imputed value of family and exchange labor, hired labor, and permanent labor; source of power costs are rents for tractor, power tiller, and draft animals; fuels include fuel used if tractor/power tiller or water pump is owned; and fees refer to irrigation fees. Net rice income is the difference between gross rice income and total cost.

Gross income	34,440.43
Average production in kg	4,291.21
Average price/kg	8.03
Total cost	15,722.77
Net rice income	18,717.66