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The Determinants of Fish Catch: A Quantile Regression Approach

Abstract. The goal of this study is to use quantile regression (QR) to find predictors of fishers' catch and compare it with OLS regression. The heterogeneous association across the different quantiles of the catch distribution was investigated using QR analysis. The findings reveal that the effect changes depending on where a fisher is in the catch distribution. In the OLS, there are several non-significant predictors that appear to be significant in quantile regression. By OLS regression, demographic variables have little effect on fishers' catch; but, in quantile regression, marital status, fishing hours, and use of motorized boats appeared to have a relatively high impact at the top of the distribution.

Key words: quantile regression, fishers, catch

JEL Classification: C14, Q22

Introduction

According to Food and Agriculture Organizations in the United Nations (2021), the Philippines ranked among the major fish producing countries in the world with a total production of 3.1 million tons of fish, crustaceans, mollusks and other aquatic animals. As cited in Oxford Business Group (2021), the Philippine agriculture and fisheries accounts for 10% of the country's GDP.

In 2019, the production volume of fisheries across the Philippines was approximately 4.4 million metric tons. In the same period, the overall production value of fishing in the country was approximately 281.7 billion Philippine pesos (Statista, 2021). The total volume of fisheries production was registered at 978.62 thousand metric tons in the first quarter of 2021 (PSA, 2021). There are 9 million registered small-scale fishers and their families rely on marine waters to provide income and food. About 85% of Filipino fishers are coastal, small-scale fishers, and catch nearly half of the Philippines' fish (RARE, 2021).

In 2016 as reported by Philippine Statistics Authority or PSA, fishing is an important source of livelihood for Filipinos, fish being the country's second staple food next to rice. On average, every Filipino consumes daily about 98.6 grams of fish and fish products.

Studies related to empirical evidence on examining relationships between variables are essential specifically on determinants of fishers' catch and knowing the nature of its impact, either negatively or positively. The goal of this study is to use quantile regression to find significant predictors of fish catch and compare them to the standard least square model. The impact of fishing and socioeconomic factors on the catch of fishers was investigated.

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Literature Review

Regression has been developed to quantify the relationship between dependent variable (response) and independent variables (predictor). Demena (2011) uses OLS regression to identify the determinants that affect the utilization of fishery resources to enhance the scanty artisanal fish catch level. Birhanu (2015) uses linear regression to detect the factors that influenced the fish production in Lake Ziway, Ethiopia. Ratna et al. (2018) determine the factors that affect the income of fishers in Lhokseumawe of West Center of Indonesia. The method used for data analysis is multiple linear regressions with the linear-log mode. Zella & Mpemba (2017) use linear regression to identify the determinants of fishing income in Coastal Households of the Indian Ocean. A number of studies have applied the standard regression or ordinary least squares (OLS) to identifying the significant factors on fishers' catch and income since it is the most common statistical method when examining the factors affecting the response variable.

Linear regression is expressed as a linear function of a set of independent or predictor variables. It assesses how the mean of a conditional distribution changes with respect to some characteristics. This method assumes that the coefficients or covariates are the same across the population (Weisberg, 2013). This approach is less informative if the influence of independent variables varies across the distribution of response variable. This model is a parametric method that requires assumptions. The linear regression has the following assumptions (Berry, 1993): (1) There should be a linear and additive relationship between dependent (response) variable and independent (predictor) variable(s). (2) There should be no correlation between the residual (error) terms. (3) The independent variables should not be correlated. (4) The error terms must have constant variance (homoscedasticity). (5) The error terms must be normally distributed. However, normality and homoscedasticity are seldom met. Failure to meet at least one of the assumptions will lead to performing a quantile regression analysis, otherwise it will result in unreliable results and misleading policy inferences.

Quantile regression is a semiparametric alternative to OLS regression. It is an econometric regression model in which a specified conditional quantile (or percentile) of the outcome variable is expressed as a linear function of subject characteristics (Koenker & Bassett, 1987). QR analysis has the ability to estimate quantile-specific effects that describe the impact of covariates not only on the center but on the tails of the outcome distribution (Bernd, 2001). Linear regression is sensitive to outliers (Draper & Smith, 2014) while QR is robust to outliers (Waldmann, 2018). It provides a richer characterization of data allowing to consider the impact of a covariate on the entire distribution of response variable, not merely its conditional mean.

Methodology

The Data

Small-scale fishers account for around 800,000 people in the Philippines. This study includes cross-sectional data from 266 fishers in Leyte, Philippines, who were randomly selected from 15 fishing sites in five different municipalities. Since the allowable margin of error used by most surveys is normally between 4% and 8%, the sample size in the study was calculated with a 6% margin of error and a 95% confidence interval. A pre-tested survey questionnaire was used to collect data from October 2018 to December 2019.

Variable Description

Daily fisher catch is quantified in kilos, and the detected predictors are classified as either demographic or fishing variables. Years are used to describe demographic attributes such as age and education. The overall number of family members is indicated by the household size, while marital status is represented by a dummy variable (1 = married, 0 = not married). Income of spouse is represented by a dummy variable (1 = has income, 0 = none). A dummy variable (1 = has income, 0 = no income) is used to indicate the spouse's income. A dummy variable (1 = yes, 0 = no) represents fishing as a primary source of income. Total number of hours per fishing session is used to describe fishing characteristics such as fishing hours and travel time from the coast to the fishing location. Membership in an organization (1 = member, 0 = non-member), presence of fishing companions (1 = with, 0 = without), and use of a motorized boat (1 = motorized, 0 = non-motorized) were all represented by a dummy variable.

Quantile regression approach

Quantile regression models the quantiles of the response variable conditional on the covariates (Koenker & Bassett, 1987). Ordinary Least Squares (OLS) regression models are commonly used in studies to determine the factors that influence fish catch. Such an approach would only reflect the impact of socioeconomic and fishing variables on the mean of the conditional distribution of catch, and would not allow for the influence to change across the catch distribution. As a result, the quantile regression analysis gives a solution to this issue. For this method to work, the dependent variable must have enough variance across quantiles for statistically significant returns to be estimated for each quantile. Quantiles provide a more accurate view of the distribution in the presence of outliers.

Research results

Descriptive analysis

Demographic and fishing characteristics were the two categories of the variables in this study. Fisher's catch ranged from 0.375 to 11.5 kg per fishing day. Fishers are 45 years old on average and have completed seven years of education. A fisher's household has an average of five individuals. Around 80% of the fishers were married, with about 30% of their spouses contributing to the family's financial requirements. Approximately 94 percent of fishers said that fishing is their primary source of income. Approximately 40% of the population became members in a fisher organization. They fish for 6.4 hours and traveled 1.4 hours from the beach to the fishing area. Food, gasoline, and other fishing paraphernalia are included in the average amount spent on fishing activities, which is PHP 279.80 (USD 5.76). Fishers utilize motorized boats to capture fish in about 36% of cases, while 66% of fishermen have fishing partners.

Table 1. Descriptive analysis of the data

Variable	Mean	Std. Deviation	Min	Max
Demographic characteristics				
Catch (kg)	2.860902	1.584132	0.375	11.5
Age (years)	45.37594	13.54634	15	89
Education (years)	6.947368	3.078387	0	20
Marital status (married fishers)	0.800752	0.400188	0	1
Household size	5.030075	2.147187	1	13
Spouse has income	0.304511	0.461068	0	1
Fishing characteristics				
Fishing as primary income	0.93985	0.238213	0	1
Membership in fishers' organization	0.369811	0.483667	0	1
Fishing hours	6.433835	3.497193	1	16
Travel time from shoreline to fishing area (hours)	1.40782	1.030522	0	6
Daily fishing cost (in PHP)	279.8045	304.635	5	1690
Daily fishing cost (in USD)	5.76	6.27	0.10	34.79
Use of motorized boat	0.362264	0.481564	0	1
Presence of companion in fishing	0.656604	0.475741	0	1

Note: 1 USD = 48.58 PHP

Source: Authors' own calculation and analysis (2021).

Quantile Regression Analysis

The effects of demographic and fishing factors on fishers' catch are presented in this section using OLS and quantile regression estimations. A quantile regression model was constructed at the 0.10, 0.25, 0.50, 0.75, and 0.90 quantiles to explore the differential effects at different points in the conditional distribution of fish catch (see Table 2).

Prior to model estimate, the OLS assumptions were checked to ensure that the findings were reliable. The errors were determined to be non-normal using the Shapiro-Wilk test, indicating that a standard linear regression or OLS model is not suggested for this investigation. As a result, quantile regression was used, which does not require any modeling assumptions.

According to OLS estimates, the model is significant at 5% (p-value = 0.0262), and the demographic and fishing characteristics account for around 8.69% of the variation in the fishers' catch. Only fishing hours and the usage of motorized boats had statistical relevance in predicting fishers' catch. Fishing hours have a beneficial impact on fishers' catch and are considerable at 1%. This amounts to a 0.087562 kg increase in catch per hour spent fishing. Furthermore, fishers who use motorized boats catch 0.432674 kg more than fishers who use non-powered boats. Demographic features, on the other hand, have no statistical significance in the dependent variable, hence they had no effect on the catch of the fishers.

Table 2. Comparison of OLS and quantile regression for catch determinants at 0.10, 0.25, 0.50, 0.75 and 0.90 quantiles

Specification	**OLS**	**Quantile**				
		0.10	**0.25**	**0.50**	**0.75**	**0.90**
Demographic characteristics						
Age	-0.00087 (0.007569)	-0.00094 (0.006747)	-0.01042 (0.007084)	-0.00667 (0.009443)	-0.01062 (0.009937)	-0.00578 (0.013735)
Years of education	0.039765 (0.031757)	0.065875* (0.028308)	0.038695 (0.029725)	0.038706 (0.03962)	0.056756 (0.041693)	0.021885 (0.057632)
Marital status (married fishers)	0.180538 (0.265456)	-0.18273 (0.236627)	0.181636 (0.248466)	0.231238 (0.331183)	0.777166** (0.348504)	1.014505** (0.481741)
Household size	0.028588 (0.045624)	0.066671 (0.040669)	0.057874 (0.042704)	0.064155 (0.05692)	0.043288 (0.059897)	-0.03932 (0.082797)
Spouse has income	0.066998 (0.215989)	0.035061 (0.192532)	0.074648 (0.202165)	0.140551 (0.269467)	0.270923 (0.283561)	-0.2249 (0.391969)
Fishing characteristics						
Fishing as primary income	0.220734 (0.406848)	0.341417 (0.362664)	0.23477 (0.380809)	-0.26048 (0.507583)	0.154351 (0.534131)	0.497464 (0.738334)
Membership in organization	0.125686 (0.206074)	0.079657 (0.183694)	-0.13576 (0.192884)	0.271734 (0.035323)	0.356353 (0.270544)	0.063815 (0.373976)
Fishing hours	0.087562*** (0.028313)	0.046272** (0.025238)	0.049644* (0.026501)	0.048634 (0.035323)	0.108271*** (0.037171)	0.114476** (0.051382)
Travel time	0.161485 (0.10093)	0.041766 (0.089969)	0.056024 (0.09447)	0.095279 (0.12592)	0.215399 (0.132506)	0.537905*** (0.183164)
Daily fishing cost	0.000382 (0.000353)	0.000294 (0.000315)	0.000552* (0.00033)	0.00066 (0.00044)	0.000317 (0.000463)	-0.00012 (0.000641)
Use of motorized boat	0.432674* (0.229901)	0.153 (0.204933)	0.465165** (0.215187)	0.310622 (0.286824)	0.307725 (0.301826)	0.927242** (0.417216)
Presence of companion in fishing	-0.1223 (0.207726)	0.001475 (0.185166)	-0.20374 (0.19443)	-0.20403 (0.259158)	0.01628 (0.272712)	0.001793 (0.376973)
Constant	1.099226 (0.69985)	-0.26535 (0.623845)	0.789814 (0.655057)	1.664907 (0.87313)	1.448477 (0.918798)	2.084147 (1.270063)

Note: *** significant at 1%, ** significant at 5% and * significant at 10%

Source: Authors' own calculation and analysis (2021).

The OLS equation was then re-estimated in quantile regression form to see how much of an impact explanatory factors might have throughout the fishers' catch distribution. The quantile regression results point to some significant changes in the catch distribution at various periods.

With the exception of the 0.50 quantile or median, where it appears to be insignificantly different from zero, fishing hours were shown to be significant across quantiles, which is consistent with the outcome of the OLS estimate. Hours spent per fishing day is considered fishing effort in this study (Clark, 2013). Fishing effort is one of the important aspects to consider for effective planning of regulatory measures and development programs in fisheries (Purcell, 2020).

However, near the higher end of the conditional distribution, the impact of fishing hours on catch is rather large. Years of education, daily fishing costs, and the use of motorized boats were found to have a substantial impact on fishers' catch in the lowest portion of the distribution. Married fishers, trip duration, and the use of motorized boats are all significant predictors of catch toward the higher end of the conditional distribution. Married fishers had a significant effect on the 0.75 quantiles, but a much higher effect on the 0.90 quantile. The use of motorized boats was more beneficial at the top of the catch distribution than in the lower quartile. At the 0.50 quantile, both demographic and fishing characteristics were insignificantly different from zero.

Conclusions

The classic OLS regression methodology was frequently employed in previous studies on examining the determinants of fishers' catch without first examining the assumptions. The findings of quantile regression demonstrate that the catch distribution differs at different places. Some fishing and demographic factors may matter at different points in the conditional contribution of catch. There appear to be significant differences between different phases of the catch. With OLS regression, insignificant variables appear to be significant at quantile regression, with their marginal effect on catch rates rising as quantiles rise.

In developing policies for fishers, the differences must be considered. Because the number of hours spent in fishing activity appears to be significant, with a growing marginal effect at larger quantiles, the local government must protect these fishers by providing training for safety measures while fishing. The local government must promote the usage of motorized boats because they appear to have a bigger marginal effect at higher quantiles. If one is not available, the LGU must help fishers to obtain one by providing financial assistance through loans.

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