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MEASURING TECHNICAL EFFICIENCY IN A SMALL-SCALE FISHERY: A causality analysis

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COLLEGE OF AGRICULTURE AND LIFE SCIENCES
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Sergio Colin-Castillo [1]

Introduction

The analysis of technical efficiency (TE) on the small-scale fishery is relevant for several reasons. While this type of fishery is highly common in developing countries, there are a very limited number of analyses assessing their efficiency. Indeed, there is no precise information on the contribution of the small-scale fisheries to livelihoods and economies in developing nations (Worm et al. 2009). Exploring this gap in the research is relevant for the decision making policy. On the one hand, small-scale fisheries can generate significant profits and be more resilient to shocks and crises; two important elements to poverty alleviation and food security. But on the other hand, small-scale fisheries may overexploit stocks, harming the environment. This problem arises when, like in this study case, the fishery is weakly regulated, with a lack of efficiency criteria to manage the lake. The fishery management should be linked with efficiency considerations (Grafton et al. 2006). Certainly, it is desirable the preservation of resources of common access like lakes, at the same time it is desirable an efficient use of the fishery. The question is what factors constrain the efficiency?

Objectives

Aiming to contribute in the knowledge of small-scale fisheries efficiency, this study seeks two objectives. Explore the causal relationship between the variables to explain technical efficiency (TE). And, estimate the TE of fishers in the Lazaro Cardenas Reservoir (LCR) a small-scale and semi-artisanal fishery in Mexico.

Method

This research applies directed acyclic graphs (DAG), a technique used to explore the causal relationship on the variables. To assess the fisher's TE, this research uses stochastic frontier analysis (SFA). To explore the causal pattern we use the PC algorithm. The null hypothesis was: fisher's skills favor the fisher performance

Model

The SFA model (Kumbhakar and Lovell 2000), follows the functional form of Battise and Coelli (1995) production frontier. It is based in Grafton et al. (2000) and Squires et al. (2003). The data (89 observations for a whole of 111) was gathered from a survey-census of the fishing communities

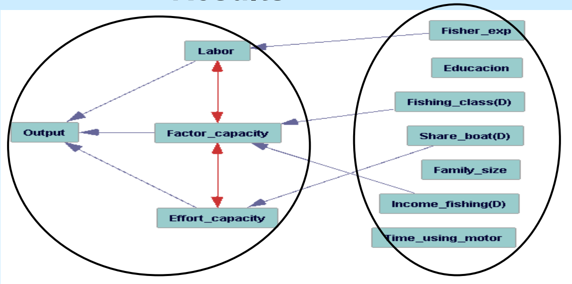
$$\ln y_i = \ln \beta_0 + \beta_1 \ln l_i + \beta_2 \ln ec_i + \beta_3 \ln fc_i + v_i - u_i^{TE}$$

where
- y : Output (kg of harvest in last week)
- l : Labor (Hours fishing per week)
- ec : Effort capacity (Combining: gas expenditure + eta1*dummy row)
- fc : Effort capacity (Combining: nets used + eta2*dummy angling)
- v : Stochastic error term. e = vi – uiTE

$$u_i^{TE} = \delta_0 + \delta_1 edu_i + \delta_2 fex_i + \delta_3 fskl_i + \delta_4 class_i + \delta_5 tm_i + \delta_6 ph_i + \delta_7 shr_i + \delta_8 incf$$

where
- u_i^{TE} : Noise term to account TE
- edu : Education (number of years in school)
- fex : Fishing experience (years)
- fskl : Interaction term (edu*fex)
- class : If the fisher have taken a class on how to fish (dummy)
- tm : Time using the motor (years)
- ph : Size of the fisher family (number of people in home)
- shr : If the fisher shares the boat (dummy)
- incf : If fishing activity is the main income of the fisher (dummy)

Results



The econometric output of the empirical model (model 1) looks consistent and do not show any violation of the assumptions. Although when analyzing the causality, the DAG show an problem in the causality structure. The elimination of factor capacity or latent variables are required to deal with the double arrowheads. Searching for improve the model specification, the model 4 in DGA (not presented here) come up with a significant improve in the econometric fit.

Concluding remarks

Model 4 in DAG matches with the best statistical fit of the model. Improving the causality structure improves also the efficiency of the estimates while the standard error become small. Matching the results of DAG and econometric output, both improve showing that it is possible to estimate a better model. Relevant in the design was that, variables used in the residual (TE) was separated. This is a methodological contribution while it to my best knowledge, the first causality analysis of TE. Overall, we do not reject that fisher skills is the most relevant factor that favor efficiency. The specific variables favoring TE are education, fisher experience, time using the motor and if the income is mainly from fishing. Meanwhile, if fisher shares the boat constraint the TE. This assessment brings useful information to improve the productivity and management of the fishery, relevant elements to assist the fishing communities, looking to alleviate the poverty and avoiding the overexploitation of the fishery

Maximum likelihood values in a joint estimation procedure using Frontier software in R

	MODEL 1			MODEL 4		
	Estimate	Std. Error		Estimate	Std. Error	
Intercept	0.529	0.753		1.063	0.691	
Ln labor	0.648	0.172	***	0.575	0.164	***
Ln effort capacity	0.288	0.118	*	0.279	0.107	**
Ln factor capacity	0.336	0.157	*			
Angling (D)				-0.865	0.250	***
z_Intercept	3.537	1.209	**	3.585	0.767	***
Z_Education	-0.277	0.146	.	-0.384	0.111	***
Z_Fishing experience	-0.078	0.042	.	-0.096	0.028	***
Z_Educ*fishing experience	0.009	0.006		0.012	0.005	*
Z_Fishing class (D)	0.800	0.615		0.704	0.630	
Z_Time using the motor	0.021	0.015		-0.128	0.058	*
Z_Family size	-0.179	0.106	.	-0.017	0.285	
Z_Sharing the boat (D)	0.007	0.270		0.031	0.013	*
Z_Income from fishing (D)	-0.240	0.320		-0.469	0.281	.
sigmaSq	0.487	0.126	***	0.376	0.062	***
gamma	0.436	0.325		0.000	0.000	
Log likelihood value	-86.17			-82.60		
AIC	202.33			195.20		
BIC	239.66			232.53		
R2 (Production function)	0.365			0.381		

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