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Economic performance and capacity utilization in a Nha Trang purse seine fishery, Vietnam

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Introduction

- Fisheries in Vietnam are an important economic sector nationally.
- It is still open access fisheries
- Coastal inshore resources have shown signs of depletion
- Vietnamese government has since the mid-1990s conducted a number of programs to develop offshore fisheries.

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Introduction (con't)

- The number of offshore vessels and fleet engine power have therefore increased at an uncontrolled rate

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- From 2010 to 2016, vessel numbers increased by 60.9% and engine capacity by 156.6%
- These large vessels not only fish offshore, but some of them operates in inshore

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Introduction (cont')

- Consequently,

⟹ Coastal fish resources are expected to be even more overexploited

→ Imbalance between fishing capacity and the available coastal fish resources

- Hence, overfishing and overcapacity seem to be central management challenges,
- Pointing to the need for appropriate regulations to control fishing capacity

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The objective

- Assess the economic performance and capacity utilization in the Nha Trang purse seine fleet in Vietnam,

- to assist in designing sustainable fisheries polices.

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Research questions

1) How did the fleet fare in 2016?

2) How much of the capacity of an average vessel is utilized this year?

3) Which are the important factors that affect capacity utilization amongst the purse seiners?

4) What are the policy implications of this study?

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Data Envelopment Analysis (DEA) method

Two common methods of measuring efficiency and capacity utilization:

-Data Envelopment Analysis (DEA)

-Stochastic Production Frontier (SPF)

-DEA is a relatively simple technique

-DEA does not require the specification of a production frontier as in SPF approach

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DEA method

There are some drawbacks of using the DEA technique:

- Sensitive to outliers
- Affected by the sample size
- Does not have a statistical sample distribution
- Does not take into account random variation

To overcome these drawbacks, bootstrapping was introduced by Simar and Wilson (2000)

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DEA method

- The deterministic second stage DEA method was commonly used for regressing the DEA efficiency on the potential variables ⟶ Standard inference was not valid

- Simar and Wilson (2007) developed the double bootstrap DEA:

- Correct the bias in the efficiency estimated from DEA method

- Provide the consistent inference for factors affecting the efficiency.

⟹ This article has applied the double bootstrap DEA method

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Definition: Input oriented capacity

- The input oriented capacity is the minimum number of capital stock or fixed inputs to produce a given level of output capacity

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- Capacity utilization here refers to the utilization of all inputs, not just the capital stock, for example, labour, variable input, fuel.
- The input oriented capacity utilization is selected as a measure of technical efficiency in terms of input orientation.

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Methodology: Capacity utilization (CU)

$$CU_{ob}(u,x) = \min \theta_j$$

Subject to

$$u_j \leq \sum_{j=1}^{J} z_j u_j$$

$$\theta_j x_{jn} \geq \sum_{j=1}^{J} z_j x_{jn} \qquad (1)$$

$$z_j \geq 0, \quad j = 1,2,..,J; \quad \sum_{j=1}^{J} z_j = 1$$

(using the deterministic DEA and double bootstrap methods)

ob = observed

u_j : output;

x_n is the quantity of input n (fixed and variable inputs)

z_j is the intensity variable

$\sum_{j=1}^{J} z_j = 1$: Variable return to scale (VRS)

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Methodology: Capacity utilization (CU)

- $0 \leq \theta_j \leq 1$
- θ_j=1 ➞ vessel capacity is fully utilized

- $0 \leq \theta_j$<1 ➞ vessel capacity is not fully utilized

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Factors affecting the capacity utilization

Truncated regression model using double bootstrap method:

$$\widehat{\delta_j} = \beta Z_j + \varepsilon_j \geq 1 \quad (2)$$

$\widehat{\delta_j}$: the reciprocal of the capacity utilization, with the value ranging from one to infinity,

Z_j: a set of the exogenous variables; for example, the socio-economic factors of fishermen

β_j : the parameters of the truncated regression model to be estimated;

ε_j : a continuous independent and identically distributed random variable, and normally distributed N(0,σ_ε^2) with left truncation at $(1 - \beta Z_j)$ for each vessel j, and it is assumed that ε_j and Z_j is completely independent.

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Data collection

- Face-to-face survey data collected from 23 of December, 2016 to March, 2017 in Nha Trang, Vietnam
- Selected a representative sample of 52 vessels (based on hull length and engine size)

Results: Economic performance for the fleet in 2016 (*measurement unit: million VND*)

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	Criteria	Mean	S.D	Min	Max
1.	Gross revenue	1755.44	790.14	450.00	3491.40
2.	Variable cost	757.60	280.28	228.00	1438.50
2.1	Fuel costs	386.21	150.70	115.2	864
2.2	Other variable	371.39	157.99	83.7	743.4
3.	Fixed cost	129.98	85.91	2.64	354.11
3.1	Maintenance and repair	126.58	85.93	0.00	350.00
3.2	Insurance and fee	3.41	1.14	0.58	5.81
4.	Labour cost	426.92	231.28	103.49	856.56
5.	Gross Cash Flow	440.94	347.17	-135.92	1205.59
6.	Depreciation	133.27	63.15	52.53	300.86
7.	Interest payment on loans	35.12	53.82	0.00	220.00
8.	Profit	272.54	286.36	-228.59	875.32
9.	Gross profit margin	0.212	0.12	-0.185	0.388
10.	Profit margin	0.112	0.14	-0.312	0.341
11.	Income per crew	28.86	12.41	7.11	50.35

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Statistics of 52 purse seine vessels

No	Criteria	Measurement unit	Mean	S.D	Min	Max
Inputs in the DEA model						
1.	Fixed cost	Million VND	298.38	139.33	79.54	715.75
2.	Variable cost	Million VND	757.6	280.28	228	1438.5
3.	Days at sea	Days	2660	897.41	600	4500
4.	Revenue	Million VND	1755.44	790.14	450	3491.4
Truncated regression model						
5.	Hull length (Z1)	meter	16.05	2.60	11.00	22.85
6.	Experience's skippers (Z2)	years	26.81	7.16	11	39
7.	Experience's skippers^2 (Z2^2)	years^2	769	364.83	121	1521
8.	Financial stress (Z3)	Yes/No	0.4	0.49	0	1
9.	Family size (Z4)	persons	4.98	1.36	3	10

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Table 5: Capacity utilization for 52 purse seiners based on the deterministic and double bootstrap DEA methods

Criteria	Hypothesis	DEA approach				Double bootstrap					
		Mean	S.D	Min	Max	Mean	S.D	Min	Max	Lower 95% CI for mean	Upper 95% CI for mean
$CU_{(ob)}$	a. CRS	0.737	0.16	0.418	1	0.693	0.15	0.39	0.967	0.662	0.741
	b. VRS	0.813	0.15	0.479	1	0.723	0.12	0.43	0.902	0.667	0.791

Table 6: Mean comparision and correlations of efficiency rankings

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Efficiency	Mean		t-ratio	Spearman rank correlation	Wilcoxon-signed rank test (used P_value)
	Deterministic DEA	Double bootstrap			
CU_crs	0.737	0.693	11.44***	0.987***	0.000**
CU_vrs	0.813	0.723	15.73***	0.962***	0.000**

****,**,*: significant at the level of 1%, 5% and 10% respectively*

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Factors affecting the capacity utilization

Variables	Coefficients	95% confidence intervals		90% confidence intervals	
		Lower interval	Upper intervals	Lower interval	Upper intervals
Intercept	2.8479**	2.1162	5.1784	2.3272	4.7834
Hull length	-0.07205**	-0.1377	-0.0293	-0.1243	-0.0322
Experience's skippers	-0.0549*	-0.1591	0.008	-0.1441	-0.0087
Experience's skippers^2	0.0013**	0.0002	0.0034	0.0005	0.0031
Finance stress	0.0215	-0.1741	0.2473	-0.1394	0.2090
Family size	-0.0066*	-0.1526	0.0113	-0.1305	-0.0016

***,**,*: *significant at the level of 1%, 5% and 10% respectively*

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Discussion (con't)

- The positive profits match well with the theory of open access fisheries for a heterogeneous fleet, and can be explained by an average (intra-marginal) vessel in a heterogeneous fleet having greater fishing efficiency than a marginal vessel with only normal profit (zero super-profit)
- This fishery can be expected to attract additional investment and continue to expand in the near future if there is not a great change in prices and costs though fuel costs increase in next years but not too much.

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Discussion

- In order to develop the fisheries sustainably:

- Buy- back vessel programs do not function well in open access fisheries ⟶ fishing effort continuing to cause on fish resources and the environment

- The Vietnamese government should review and assess some current subsidy schemes (preferential loans with subsidized interest rate, fuel subsidy) that may contribute to overexploitation of offshore fish resources if they are continued

Conclusion

- These vessels had positive economic indicators with the average of profit of 272.54 million VND, and profit margin of 11.2%.
- This result also suggest that there is a room for reduction of the productive inputs to yield the current output (under VRS being 0.724 using the double bootstrap DEA).
- Some factors could enhance the capacity utilization such as hull length, family size (as proxy for payment for crews), and skipper's skill.

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Conclusion

- Vietnamese government might wisely be wary of encouraging increased effort

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- Double bootstrap method should be more widely used to measure the efficiency in fisheries sectors considered to be highly stochastic (subject to random fluctuations)

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Expansions

- How will the results change if we adopt the physical measures for estimating the capacity utilization

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- A further study should include panel data to measure the change in the economic performance and the capacity utilization in long term


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