SEVERAL MAJOR FACTORS INFLUENCING REVENUES OF THE YELLOWFIN TUNA LONG-LINING FISHERY IN PHU YEN PROVINCE

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ABSTRACT

Vietnam is in the club of countries gifted with the long coastal line, and strong in marine features accordingly. Fishing operations are artisan characteristic and the management method is primarily open – access. Since the past few years, the yellow fin tuna long- lining fishery has become one sub-sector experiencing high growth rate in the region of South Centre of Vietnam. Phu Yen Province has been a special case in point. Fishers there have invested much capital into developing these ventures that culminates in the sharp increase of vessel numbers, total catch and therefore revenue. This paper is to look into some factors namely engine power (capacity), fishers, production organizations, equipment values, vessel age, baits, education level of skippers, which together impact revenues of the long-lining fishery in Phu Yen Province. Results of the model under examination are statistically significant. Generally, the research findings are consistent to those previously inferred in international papers. Based on this research, some orientations for management have been suggested.

Keywords: Long-line fishery, management fisheries, revenue fisheries

The production function is applied across disciplines to understand the relationship between the quantities of productive factors used and the amount of product obtained. For its common usage, its practical and academic dimensions have been extensively discussed in economic discourses. Economists across the globe agree on the notion that production outputs are generally determined by a set of fixed and variable inputs, in addition to a series of environmental and management factors. Cobb and Douglas (1928) employed the logarithmic function to codify this connection. Later, the general model has been developed and adjusted to better explain factual conditions in the fishery sector. Among pioneers is Schaefer (1954) who postulated that under given circumstances, the relationship between effort and catch can be expressed in a quadratic convex curve whereby any combination between each catch and effort level lying on the curve is defined as biologically sustainable. The peak of the curve accordingly represents the maximum sustainable yield. The model suggests that the maximum sustainable yield is subject to change as a result of fluctuations in catch and effort factors. A step further from Schaefer's model (1954), the bioeconomic model introduced by Gordan and Schaefer (1957) indicated that the association between revenue and effort can be expressed in a quadratic convex curve whereby any combination between each revenue and effort levels lying on the curve is defined as biologically balanced. Meanwhile, the costs line goes through the origin O and intersects the revenue line at the point called bioeconomic equilibrium. At this point, the entire stimulus to expand or contract fishing efforts (it means no triggers for potential entry or exit) will be eradicated because profits have reached the average scope, equivalent to other sectors and industries. Recent studies put more concentrations on variables associated with vessels that influence the total outputs. Khem and Pingsun (1999) investigated how sensitive such factors as costs, catch size, fisher skill and educational level are to revenue as a whole. Taylor and Prochaska (2001), Dann and Pascoe (2001) discovered that the number of crew on board, age of vessel, and number of gears used have significant impacts on fishing efficiency. In other studies, Erik Lindebo (2004) explored that the fishery capacity depends much on investment capital, labor size, engine power, registered loading capacity, landings, and fishing days at sea. Joining efforts is Sean Pascoe (2006) who presented hard evidence to prove that days-at-sea affect profits of fishing vessels. Another model recently developed by Sean Pascoe and Simon Mardle (2003) proposed that outputs of a fishery can be influenced by six variables including natural conditions, vessel characteristics, gear properties, state management, labors and management, and factor supply status on the market. However, rarely have similar studies been found in Vietnam (with exception to Long L.K (2006)). Against this background, the study is designed to consider impacts of several factors on revenue in the yellow fin tuna long-lining fishery[1] of Phu Yen – a typical fishing province in the southern central part. It aims to lend more substantiation from local specific conditions to the existing knowledge base of relevant literature. Econometric method will be used to test the causal relationship, if any, among input parameters.

It is reported that till December 2005, the total number of vessel is registered at 4.070, operating in a variety of areas namely: lift netting, trawling, gillnetting, purse seining, long-lining (with 725 vessels), in addition to logistic services. The tuna long-lining fishery has enjoyed the remarkable growth rate, with the total production of 1800 tonnes in 2000, going up to 5.040 tonnes in 2005 (accounting for 44% of the regional output and 27% of the national production). Since tuna catch has played a significant role in the local economy, the examination on factors influencing economic performance of the tuna long-lining fishery in Phu Yen Province is becoming strongly relevant for making informed decisions both at business and policy-making levels.

HYPOTHESES AND THE RESEARCH MODEL

In a broad sense, fishing is defined as a material manufacturing sector, bearing characteristics of other production processes while subject to changes in the environment and natural resource status. Output is often measured by parameters such as revenue (Flaaten, Heen & Salvanes, 1995; Pascoe, Coglan, & Louisa,2002; Long L.K, 2006), total catch (Pascoe, Hassaszahed & Anderson,2003; Pascoe & Coglan, 2002; Tinley, Pascoe, & Coglan, 2005; Andersen, 2002; Habteyonas & Scrimgeour, 2003), CPUE (Taylor & Prochaska, 2001; Dann & Pascoe,2001; Mario, Paolo, & Paola, 2003; Pascoe & Herrero, 2004). In this research, revenue is used to assess the overall performance of the tuna long-lining fishery in Phu Yen Province.

Most studies outside Vietnam have so far been carried out using multivariable regression method, accompanied by the quadratic nonlinear function, to assess the impacts of inputs on revenue. Engine power (Tinley, Pascoe, & Coglan, 2005; Pascoe & Herrero, 2004; Lindebo, 2004; Pascoe, Hassaszahed, & Anderson, 2003; Habteyonas & Scrimgeour, 2003; Pascoe & Coglan, 2002; Andersen, 2002) influences output factors on both linear and quadratic patterns, positively correlated in the former case and negatively in the latter. Sean Pascoe and Ines Herrero (2004) found out that the number of fishing trips is non-linear associated to the overall performance of squid and shrimp harvesters in Spainish, also positively correlated in the linear function and negatively in the quadratic function. In other research work, Taylor and Prochaska, Dann and Pascoe (2001); Erik Lindebo (2004) were consistent with their findings that the number of crew on board in fact places certain part in determining total catches. For instance, Taylor and Prochaska postulated the increase in the crew number will be followed by increase in production, thus, labor and production in this case have increasing linear relationship. Diana Tinley, Sean Pascoe, and Louisa Coglan (2005) conducted the research on the impact of input factors, with a focus on equipment value, on the total catch of bottom trawlers in Dutch. The findings are similar in the sense that linear function demonstrates the positive association with total production while

[1] For convenience, from here onwards, the yellow fin tuna long-lining fishery can be mentioned in shorter forms such as tuna long-lining fishery, long-lining fishery or long-lining.

quadratic function works the other way around. Also, Long.L.K (2006) uncovered the similar interactive pattern but using revenue as the output factor instead. Pascoe, Sean and Coglan, Louisa (2002), Habteyonas.Z. and Frank Scrimgeour(2003) discovered skipper and crew skill can significantly directly explain for the variations through measurable factors namely educational level, working years of skippers and crew members. As far as this study is concerned, no specific research quantifying the effects of bait and production organizations on the fishing performance have been carried out. As a consequence, the impact of bait costs and vessel size on revenue in the tuna long-lining fishery has become the area of focus in this study.

Technical characteristics of vessels can be expressed in variables such as: vessel age, engine power, vessel length, main engine capacity, loading capacity, and equipment value. As can be suggested from the covariance matrix, vessel length and engine power are significantly related. The similar result can be applied to loading capacity and engine power. In practice, according to state regulations, the fisheries stratification system, let's say drawing the line between coastal and offshore fisheries, is primarily determined by engine power. It is therefore logical that engine power, not vessel length or loading capacity, will be targeted as the main emphasis of the study. Vessel age and engine capacity will appear in the research model. Equipment value has more to do with electric and nautical devices. The effect of management and production organization variable on fishing efficiency can be visualized as the influence of separate vessel fleets/groups, specifically measured by the number of vessels. Crew on board constitutes another important input used to assess the causal relationship between the set of inputs and output studied. Labor quality is measured by educational level and working years. However, due to technical limitations in sampling handling, information on working years of crew, not of skippers, has been collected. As a result, skipper quality is concretized solely via educational level. Moreover, the number of fishing trips is also expected to influence variations in catches.

As mentioned before, in order to measure fishing outputs, three parameters including revenues, catches and CPUE have frequently been used in other studies. Nevertheless, given limitations in data collection process, information on the specific catch per fishing trip is unavailable, hence, the annual average figure is used instead. As can be observed, catch composition normally varies with tuna, swordfish, sailfish, or squid. When working with vessel owners who historically speak from their memories rather than from a systematic recording work, it is more reliable to obtain the information on revenue. Another reason is that vessel owners often manage to remember how much they get from fishing in monetary terms since they use this sum to compute salary and decide on future investment. This habit in calculation justifies the selection of gross revenue as the only output factor under investigation. The proposed research model is non-linear since in fisheries where biological characteristics represent the greatest constraint to growth, revenue can not increase indefinitely. In general, the relationship between input factors and revenue can be expressed in the following model:

$$DT = \alpha_0 + \alpha_L L + \alpha_C C + \alpha_T T + \alpha_H H + \alpha_B B + \alpha_M M + \alpha_V V + \alpha_X X + \alpha_{LL} L^2 + \alpha_{CC} C^2 + \alpha_{TT} T^2 + \alpha_{HH} H^2 + \alpha_{BB} B^2 + \alpha_{MM} M^2 + \alpha_{VV} V^2 + \alpha_{XX} X^2 + \varepsilon_R$$

Whereby:

L : Labor	M: Bait costs (1.000 VND)
T: Vessel age (years)	X: Number of vessels per fleet (vessels)
C: capacity (CV)	B: Equipment value (1.000 đ)
H: Number of fishing trips (trips)	DT: Annual average revenue (1.000 đ)

V: Educational level of skippers ε_R : Error

What sets this research model apart from other ones is that production organizations and bait costs elements have been included and that the number of variables studied is more than conventional (8 variables). To make the research findings more relevant and valid, several expected hypotheses will be proposed. These suggestions are deduced from previous studies as well as from results of in-depth interviews with both experts and fishers.

Hypothesis 1: Engine capacity is positively correlated to revenue but with an upper bound as a result of finite resources and existing regulations on fishing for a sustainably developed fishery.

Hypothesis 2: The age of vessels is positively related to revenue. The longer do vessels participate in fishing activities, the more revenue can they earn. But it is noteworthy that the increase is not indefinite because vessels, together with on-board equipment, will become outdated and degraded across the time, resulting in the downward trend in revenue.

Hypothesis 3: Equipment value is positively correlated to revenue. The investment should be done at a proper scale for efficiency purpose. Equipment under examination is composed of compass, short-range and long-range navigation devices. Equipment value is considered the factor considerably influencing gross revenue of fishing vessels. More equipment can be translated to higher revenue but the increasing trend is finite, then, the optimal revenue can be obtained only at a reasonable level of investment.

Hypothesis 4: The addition of fishing trips helps to bring about higher revenue. It should be understood that more fish in the sea allows less time for fishing, and therefore more fishing trips per year.

Hypothesis 5: The number of crew on board is positively related to revenue but the increase is finite.

Hypothesis 6: The number of vessels in an organized fleet has certain impact on individual income. As managing and organizing skills among fisher folk are still limited, for efficiency, the fleet size is expected to remain at the manageable level.

Hypothesis 7: Educational level is positively related to revenue. Higher educational levels conventionally give skippers more chance to better employ equipment, accumulate more experiences and better respond to different fishing situations, thus, producing better performance relative to others.

Hypothesis 8: Bait costs, to most of fishers interviewed, are not the preferred investment amount because fishers tend to make use of by catch available as fishing baits. Squid baits may consume a considerable amount of money but to fishers' experience, they may work more effectively than other kind of fish baits. It is expected that bait costs positively influence revenue.

RESEARCH METHODS

Interviewees are fishers working in the tuna long-lining group. The research unit is individual vessel operating in Phu Yen Province (725vessels were registered in total in 2005). Samples are selected based on capacity category and geographical locality. To ensure the sample concentrations, two fishing wards including Phu Lam and Ward Six where the majority of tuna long-liners (approximately accounting for 60% of the whole province) are found. About 120 vessels are selected for direct interviews. Present at the interviews are vessel owners, their families and representatives from ward-level fisheries divisions. Both cross comparison and timeline comparison techniques are examined, leaving only 80 samples qualified to be processed (making up 10% of the total population, General Statistics Bureau 3%, number of samples n≥30). Data obtained can provide information on vessel owners, number of vessels, engine power (capacity), vessel length, loading capacity, cost breakdown for a fishing trip, labor, vessel's year of building, working years, educational level, average income, number of vessels in a fleet, bait costs, equipment breakdown cost, breakdown investments, investment timing, depreciation duration, major repairs, average revenue per fishing trip, the average number of fishing trips per year.

Analysis method: All data collected will be codified into variables, entered into SPSS 10.5 software, checked, processed, and intepreted. All variables are tested to derive the final model that can produce the best prediction quality. The model results continue to be tested using F-test which reveals that all parameters in the model is statistically significant. These statistical findings will then be compared technically with those from other studies.

RESEARCH FINDINGS

The targeted vessel group in Phu Yen Province has the average capacity of 160 CV, relatively high as compared to other vessels in the South central region. The number of crew on board averages at 9 per one vessel. The educational level of skippers typically remains at grade 7 while it is not rare to see some skippers just stop their formal education at the second grade. Related to vessel age, the long-lining fishery has recently been developed since 1997, so, the vessel's usage duration is in average less than 4 years, with the exception of 13 years to the vessels technically upgraded from the old ones used for catching flying fish. The number of fishing trips is critically reliant both on catch size and engine capacity. High frequency of trips is more commonly observed among smaller vessels and/or in main seasons, averaging 7.3 trips/year. A trip is calculated to cost around VND 92.6 million a year in which baits consume a significant share. Bait costs vary sharply with vessels dependent on the volume used. Production is organized either individually or collectively based on kinship. Certainly, the latter form is by far preferred, and to illustrate this point, 98% of vessels under investigation operate in groups. In average, each group is made of 4 vessels contributed by relative members. The annual revenue is computed at VND 465.9 million, with the performers at the two ends of VND 880 million and VND 40 million, respectively.

Table 1: Data description

	Minimum	Maximum	Mean	Std. Deviation
Engine capacity	45	165	105.94	42.98
Educational level	2	12	6.93	2.29
Number of crew on board	8	11	9.42	0.87
Vessel age	1	13	4.15	3.14
Equipment value	7,800	43,200	21,483.50	7,465.23
Number of fishing trips	3	11	7.35	1.53
Annual bait costs	40,000	200,000	92,643.75	26,101.96
Number of vessels per group	2	9	4.38	1.22
Annual average revenue	40,000	880,000	465,949.38	121,429.11

Using regression technique with OLS method (Ordinary least square) and under support of SPSS 10.5 software, some initial "hard" results have been produced as follows:

Table 2: Parameter estimation of the model

Parameters	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	- 4,649,404.76	1,123,407.02		4.14	0.00
V	5,371.82	2,804.26	0.10	1.92	0.06
N	- 54,625.20	13,517.37	- 0.23	- 4.04	0.00
H	40,580.20	6,608.43	0.52	6.14	0.00
L	891,336.89	250,037.51	6.46	3.57	0.00
L^2	-47,509.02	13,773.69	-6.25	- 3.45	0.00
B	9.399103	4.22	0.59	2.23	0.03
B^2	-0.000183	-0.000	- 0.47	-1.93	0.06
M	1.22	0.30	0.28	4.11	0.00
X	74,924.30	39,064.43	0.69	1.92	0.06
X^2	-7,167.67	4,158.98	- 0.62	- 1.72	0.09
C	4,682.04	1,604.46	1.68	2.92	0.00
C^2	- 18.11	6.66	-1.46	- 2.72	0.01

(R^2= 0,633 and adjusted coefficient of determination R^2_{adj} = 0,602, F value at 20.52 and level of significance at 0.00)

In the model, vessel age is expected to generate variations in revenue but findings show that the relationship is statistically insignificant. Meanwhile, the other variables are tested to be significant. As can be seen from the model, there is a pronounced year-to-year difference in revenue. If other variables are kept constant, in 2005, the average revenue declined by VND 54,625,200 against the year 2004.

The adjusted determination coefficient R^2_{adj} is computed at 0.602, interpreted as 60.2% of changes in revenue can be explained by variations in engine capacity, fleet size, bait costs, educational level, equipment value, number of fishing trips, and number of crew on board. F value is computed to be 20.52 with the significance level of 0.00. The result of F test allows to conclude that there exists at least a coefficient $\alpha \neq 0$, which means there is at least one variable that have causal relationship with revenue.

At the initial stage, the increase in capacity will result in the corresponding increase in revenue but the trend starts to reverse slightly at the level of 129.2 CV (130 CV), and sharply at 200 CV. To the point of 260 CV, revenue takes the minus value. With respect to revenue, the optimal number of crew on board is calculated at 9.4 per vessel because once exceeding this, revenue begins to go down. Similarly, the amount of VND 25,672,000 in equipment value and the number of 5.3 vessels in a fleet combined are considered the optimal choice since at these levels, they show to be most productive. These research findings are consistent with discoveries on impacts of engine capacity conducted by Tinley, Pascoe, & Coglan (2005); Pascoe & Herrero (2004); Lindebo (2004); Pascoe, Hassaszahed, & Anderson (2003); Habteyonas & Scrimgeour (2003); Pascoe & Coglan (2002); Andersen (2002) as well as those on impacts of crew size undertaken by Taylor and Prochaska, Dann and Pascoe(2001); Erik Lindebo (2004), and on equipment value done by Diana Tinley, Sean Pascoe, Louisa Coglan (2005) Long.L.K (2006).

CONCLUSIONS AND RECOMMENDATIONS FOR POLICY-MAKING

Revenue of the tuna long-liners is influenced by the following factors namely engine power, number of crew on board, fleet size, number of fishing trips, educational level of skippers, bait costs, and equipment value. Given these derived facts, several suggestions are prescribed with an aim to enhancing the overall performance of the long-lining fishery in Phu Yen Province.

First: **Production should be organized into fleets/groups**.

As can be revealed from the research model, the number of vessels per group has marked impact on revenue, demonstrated by the coefficient α_X at 74,924.30, α_{XX} at -7,167.67. The results suggest that fishing fleets, typically made up of 5.3 vessels, represents the best option for fishing organization.

In Japan, almost all fishing vessels take part in cooperatives since fishers are conscious that these bodies can help to find outlets for their fishing products. Cooperatives here function as representatives of fishers for fisheries services at auction centers.

In Norway, fishing associations collect 1% fees of the total sales from member fishers. These entities play an intermediary role in negotiating the best prices, providing fishers with information and updating market prices and conditions, else predicting the best timing for profitable landings. This way helps to establish an equitable raw material market. In addition, these agencies create auction platforms in order to ensure interests for both fishers and processors. Apart from those functions, they put forward regulations and management principles that are adjusted according to different timing and geographical areas. They control the total production through the clause stipulating non-repayable towards excess catch.

Based on experiences across the world and hard data findings from the model, it is suggested that production fleets composed of 5-6 fishing vessels be formed, reflecting fishers' optimal scale of management. All fleets next participate in larger bodies, specifically local fisheries associations, who should function as immediate services suppliers including the provision of information on catches, prices, quantity, and place to land fishing products which all together generate the best benefits for fishers.

Second: **Engine capacity of newly-built vessels for long-lining fishery should be oriented/controlled**.

Under current regulatory framework, engine capacity is considered an indicator used for categorizing fishing sub-sectors. In the research model, it is revealed that engine capacity has linkage with revenue at statistically significant values α_C = 4,682.04 and α_{CC} = -18.11. The optimal capacity level for long-liners is computed at 129.2CV. This finding shows to be consistent with those of previous studies about performance assessment of long-liners across 3 categories 45-89CV, 90-140CV, and over 140CV in which the group 90-140CV is defined the best performers. Pham Ngoc Hoe (2006) suggested an artisan vessel model as a workable alternative in the long-lining fishery at the capacity level of 150CV. Since economically statistical evidence available is insufficient to come up with reliable conclusions, this allegation is open for further testing.

There exists a capacity race among recently built vessels, producing strongly powered performers at sea. Nonetheless, it is recommended that the capacity level remain at 130CV, ranging within 20% limit. This variation is permitted since at these levels, revenues concentrate around the optimal value.

Third: **Skipper and crew educational level should be enhanced.**

The research model proposes that educational level of skippers and crew has visibly influenced revenue. Most fishers admit that poor formal education is generally accompanied by limitations for continuing learning. Understandably, to many, it is challenging to acquire professional certificates required by their jobs such as licenses for captains or for chief engine operators. It is even not less so as to obtain skills utilizing other modern electronic devices. In fact, fishers themselves want to be further trained for efficient working methods and skills.

The issue open to discussion is how to come up with an effective training method so that certificates and licenses granted to fishers represent reliable indicators for operating skills. Practical, problem-solving approach may be more preferred in training this type of audience. This in turn pose technical questions to training centers regarding facilities and course timing arrangement that enable fishers to participate in regularly.

Fourth: **Investment in fishing equipment should be instructed**

Notifications No.02/2006/TT-BTS integrated requirements about the minimal reception power of communication devices into the license granting form for safety at sea. The Article 5 of Decision No. 66/2005/NĐ-CP on the human and asset safety in fishing operations states that all fishing vessels must be "*sufficiently equipped, including devices for rescuing, communicating, and protecting both human and assets according to the stipulated standards. Regulations and technical processes for utilizing safety devices on board need to be formulated and publicized",* "*For offshore fishing operations, it is mandatory for vessel owners to purchase insurance for all crew, and to inform the capacity of their communication devices to the fisheries agencies where registration is undertaken* ".

The research model suggests that equipment investment is correlated to revenue, with α_B= 9.399103 and α_{BB} = - 0.000183. Communication equipment commonly seen on board are long-rang and short-range devices. This sum of investment varies greatly across vessels, with some conforming to the regulations while others failing to do so.

Anyway, once legal framework for standard equipment on board has been introduced, the remaining job has much to do with fisheries extension centers where specific instructions on what and how to equip fishing activities should be frequently delivered. Some equipment such as salinity meters, temperature measuring instruments, fish-finding devices should be furnished. The long-lining of SEAFDEC has supplied information on fishing areas, temperature, and salinity of different type of tuna. Le Hong Cau (2004) defined the optimal range for high catch levels of striped tuna of T = 28,6 ± 0,7^{0}C and salty level of S = 33,50 ± 0,40‰

Impacts of equipment and technical aspects on revenue have been proved statistically. It implies that fishers need to be encouraged to invest in equipment on board and learn how to operate them effectively.

Fifth: **Fishing techniques should be guided**

As the model indicates, baits consume a significant part of cost components of the tuna long-lining fishery in PhuYen Province and they influence revenue at the coefficient α_M=1.22. Despite their sensitivity to revenue is not high, as the practices can speak, fishers prefer to use flying fish and squid as baits. Squid baits conventionally produce more revenue for vessel owners since they attract more tuna fish and therefore translate into more catch. In case fishers can not afford to buy squid baits, they use flying fish instead. The factors that lead to the increase in by catch, as attributed by fishers, are that flying fish baits are less attractive to fish and historically entail longer fishing trip duration.

With respect to the tuna long-lining fishery, relevant regulations on marine resource preservation specify that marine turtles be protected. Thus, hooks need to be designed in conformity with required technical specifications (in curve shape) that allows the escape of turtles or. However, these regulations have not been respected in practice, partly because fishers see it unprofitable to use such type of hook. They alleged that if turtles can escape, so does tuna fish. At the international conference, SEAFDEC experts announced an interesting conclusion that production remains unchanged as to whether J-shaped or curve-shaped hooks are used whereas squid baits can make a positive difference. Anyway, curve-shaped hooks seem to be unworkable in the current context if costs and benefits in money's terms are the most concerned priority. This situation again calls for the positive intervention from the government as well as from marine turtle protection entities worldwide.

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