STRATEGIES OF GAME THEORY IN THE MARKETING OF MARINE CATCH FOR SMALL, MEDIUM AND LARGE FISHERMEN.

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ABSTRACT

There are two distinctive issues in marketing of fishermen catch; one is the issue of agent-principal relationship due to asymmetric information whereby the agent takes over the function of marketing once the catch is landed. There has been allegation that giving of credit is a form of trade that benefits the agent who has control over the daily fishermen catch. Another form of marketing strategy which I believe have never been investigated before at least in Malaysia or in fishing industry is the way by which fishermen catches are brought to the market place. Many studies and analysis found that those who have dominant strategy in the market will be affected by the way simultaneous or sequential, collusive or non-collusive marketing strategies. This study is intended to verify the theoretical findings of game theory with the empirical evidences using real world data from fisheries statistics.

Keywords: game theory, simultaneous, sequential, collusive and non-collusive strategies.

INTRODUCTION

Small-scale capture, as a traditional fishing activity and its trade have been passed down from the earlier generation of fishermen to the current generation with endless social, economic and resource management issues. It began with the socio-economic problem of poverty among the fishermen community during the 1950s and 1960s. Just after independence the blame was on low adoption of fishing technology which unable them to obtain higher productivity. However, the nature of problem that has been evolved around the fishermen's productivity and poverty later around 1980s and 1990s shifted to resource management. Fisheries have been in open-access for a long period of time such that a possibility of depletion due to over-fishing is most likely. The problem of resource depletion could be a major issue since in Malaysia the development of marine fisheries has always overshadowed that of inland fisheries and fishing activity has been the livelihood of most fishermen. The encroachment of Malaysian exclusive economic zone (EEZ) by foreign vessels had worsened the issue of resource depletion along the coastal areas which led to a joint venture of Thai-Malaysian deep sea fishing.

The above issues revolved around the supply, that is, production and productivity. On the demand side Malaysian population is ever-growing calling for more food production, especially rice, fish, livestock, poultry and others. As the volume of trade in fish marketing is going to persist and becoming more important in the future the involvement of small fishermen referring to those operating vessel size below 25 GRT are likely to be marginalized in this competitive market by the larger vessel operators of 25 to <40 GRT and 40 to <70 GRT. Vessel size of 70 metric tons and above is supposed to be the deep sea operators which we have not considered in the analysis. The objective of this paper is to investigate how marketing strategies--collusive or non-collusive, simultaneous or sequential, can have influential impact on the fishermen profitability according to the strategic game theory.

BACKGROUNDS OF GAME THEORY AND ITS APPLICATION

The game theory has developed its application mainly in mathematics since its inception in 1944 by John von Neumann and Oskar Morgenstern. Its usage has become more diverse in a broad field of academia after John Nash was proclaimed the Noble Price winner 1994 with the popular Nash equilibrium strategy. Game theory is a branch of applied economics that utilizes mathematics as the tools for analyzing possible strategic options in human interactions in diverse academic fields ranging from economics, business, psychology, and biology to sociology, politics and philosophy. The purpose of human interactions is seen as a way to trade and exchange goods in economics and business that yield benefits to the interacting players in terms of utilities or outcomes. These outcomes are generally in the form of monetary returns or profits. As rational human being the choice of a decision is made strategically to attain best outcome over the opponents just as in the games. The best outcome to a particular player is arrived after considering the expectations and the likely actions of the other players and vice-versa. When game theory was first developed by John von Neumann and Oskar Morgenstern (1944) the application was limited to mathematical outcomes, but now the philosophical aspect of it has deepened and generalized to include non-parametric analyses.

According to Stanford Encyclopedia of Philosophy (revised version March 10, 2006 pp.2-3), long before the game theory was introduced, Cortez, the Spanish conqueror landed in Mexico with a small force to fight a much larger force of Aztecs. Fearing that his troops might retreat he ordered the ship which brought them to Mexico to be burned. The decision taken by the Cortez and his troops was gallantly regarded by the enemy and demoralized the Aztecs. They retreated to the hills giving victory to Cortez without the bloodshed.

Parametric outcomes as in mathematics and statistics are considered less challenging and easy to predict relative to non-parametric games. Suppose a person is given the choice to cross the bridge from point *x* to point *y*; with three options of the least dangerous bridge of zero percent risk, followed by one with some degree of risk in terms of steep slopes leading to the bridge, and finally the most riskiest bridge due to the presence of deadly threats. It is rational to choose the least dangerous bridge to achieve the best outcome based on this strictly parametric decision. However, non-parametric games are more difficult to predict because the opponents are not passive like those of the deadly threats of steep slopes and dangerous animals. The decision is somewhat complicated when the zero risk bridge is located a distance away from the starting point with difficult upstream while those risky crossings are close by. The game becomes more complicated when the situation of non-parametric is brought into the picture. Suppose the person is a fugitive irrespective of his innocent or guilty as he is being charged by his pursuers. Surely the zero risk bridge is not likely the best option. In real world this kind of decision making has to be made rationally and strategically. We have to understand the game and the likely strategies chosen by the rivals since we may involuntarily become players in an unintended game.

The example often cited in game theory is the Prisoner’s Dilemma, which was first discussed by Albert Turner, in the 1940s (Nicholson 1997). Albert Turner was Nash thesis advisor. In Prisoner’s Dilemma two persons were caught for committing a crime but there was insufficient evidence to extract a confession. The judge decided to separate them to avoid conspiracy of an answer and read them the penalties; " if you confess you will be given a lighter sentence three years each (3, 3), and if you don't confess while your friend does you will get ten years jail while your friend will be jailed for six months, (10, ½), but if both of you don't confess of committing the crime you will be sentenced to two years jail each, (2, 2)." The prisoner's safest decision choice is to confess since if his friend does not confess he will get only ½ of a year jail sentence, and if his friend also confesses they will be sentenced to 3 years each. Although the decision not to confess carries the least sentence of only 2 years it is highly risky (10 years) when his friend chooses otherwise. The decision not to confess is the best option to the prisoners but it is certainly not safe.

The Prisoner's Dilemma was in fact one of the first responses to the Nash equilibrium, referring to John Forbes Nash which shared the 1994 Noble Price with John Harsanyi and Reinhard Selten that needs no mention in game theory,

> "…that contributed remarkably to the notion of equilibrium that has been widely applied and adopted in economics and other behavioral sciences." (Holt and Roth 2004 p.3999).

However, in the "*social dilemmas*" the Nash equilibrium would not necessarily be a good predictor of behavior if the prisoners are allowed to cooperate (Melvin Dresher and Merrill Flood 2005). Nash equilibrium refers to the game in which the non-cooperative player decides on a strategy given the decisions of the opponent players.

The crucial aspect of game theory that help players in making choice of a rational decision on a particular strategy depends largely on the availability of information about the opponents. In the case of Prisoner's Dilemma the players are separated and located in different cells and each person is supposed to have no information whatsoever about his colleague's strategy. If they have perfect information then their dilemma of making the choice would not arise because they can collude to choose not to confess, (2yrs., 2yrs.) instead of confessing (3yrs., 3yrs.). If the players knew in advance that his associate had chosen confess then his decision to confess would be Nash equilibrium and the solution is the second best since both loss one year of a free life outside the prison. The current study is basically a parametric decision making which is evaluated at optimal economic outcomes. These outcomes are profits to the three categories of vessel operators; the small, medium and large fishermen.

METHODOLOGY

In this study we are going to focus our analyses on three different forms of economic aspects of game theory namely, the non-collusive strategy, the collusive strategy and sequential strategy. The first two marketing or more appropriately the output distribution strategies assumed that the players—the fishermen or their sale agents are marketing their catches simultaneously. The simultaneous non-collusive mode of distribution which is perhaps the common method of marketing of fishermen daily outputs refers to the individual strategy whereby they do not cooperate, that is, there is no team work whatsoever between one fishermen and the other fishermen in marketing of their daily catches. In contrast to the non-collusion is the collusive strategy whereby individual fishermen cooperate as in team work in the marketing of their products. The objective of game theory in the simultaneous collusive and no-collusive marketing systems is to identify whether or not economic returns to the operators under these conditions differ, suppose to be evaluated under an optimal condition.

The sequential marketing strategy refers to the system of distribution of fishermen's output in chronological order, that is, if there are only two players there will be the first and then the second person/fisherman to market their catches. Economists believe that there are significant differences of economic returns accrued to the players in each order depending on the market domination of these individual operators. Some economists even believe that the first mover is always the likely gainer as he/she has the advantage of first hand of market information, such as the ability to monopolize the temporary market situation before the arrival of the second and succeeding players (Pindyck et al. 2006). We will use data from Annual Fisheries Statistics 2004 to test the hypothesis that the first mover is better off then the second mover if the second player is non-dominant in this investigation.

Non-collusive simultaneous strategy

In a two-person game, suppose P_1 and P_2 represent the ex or on shore and the wholesale fish prices respectively. Fishermen's catch for small vessel of less than 25 GRT is represented by q_1 and the catch of medium size vessel of 25 to less than 40 GRT is represented by q_2 then the linear interaction functions for non-collusive are given by

$$p_1 = f_1(q_1, q_2) = a_0 + a_1 q_1 + a_2 q_2 \quad for\, a_1 \angle 0, a_2 \angle 0 \tag{1}$$

$$p_2 = f_2(q_1, q_2) = b_0 + b_1 q_1 + b_2 q_2 \quad for\, b_1 \angle 0, b_2 \angle 0 \tag{2}$$

Equations (1) and (2) above are initially derived from the indirect demand functions for small vessel catch, $p_1 = f(q_1, p_2)$ and the medium vessel catch, $p_2 = g(q_2, p_1)$ by simultaneous solution technique. This is achieved by substituting the RHS of small vessel demand function into the medium vessel demand and vice-versa.

Given the total revenue $R(q_i)$, total cost $C(q_i)$ and the net return equation $\prod(q_i)$ for i=1 and 2, they can be shown as

$$R(q_1) = f_1(q_1, q_2)\, q_1 \tag{3}$$

$$R(q_2) = f_2(q_1, q_2)\, q_2 \tag{4}$$

$$\prod(q_1) = f_1(q_1, q_2)\, q_1 - C(q)_1 \tag{5}$$

$$\prod(q_2) = f_2(q_1, q_2)\, q_2 - C(q)_2 \tag{6}$$

The differentiation of the net return with respect to the outputs; q_1 and q_2 and setting the results equal to zero the vessel's reaction functions are obtained and should be equal to the following:

$$q_1 = \frac{a_0}{2a_1} - \frac{a_2}{2a_1} q_2 \tag{7}$$

$$q_2 \quad = \quad \frac{b_0}{2b_2} - \frac{b_1}{2b_2} q_1 \qquad (8)$$

Substituting the right-hand side of q_2 in (8) into (7) and solving for q_1 the catch for the non-collusive optimal quantity of small vessel can be subsequently estimated, and substituting the result of optimal q_2^* into equation (8) q_1^* is obtained. These optimal catches of small vessel (q_1^*) and medium vessel (q_2^*) first should be used to estimate the efficient prices offered by the small vessel and the medium vessel of equations (1) and (2) above.

The non-collusive net economic returns for the small and medium vessel operators are calculable from the net economic return functions of equations (5) and (6). They should be equal to $\prod(q)_i^* = p_i^* q_i^* - C(q_i^*)$. The actual estimations of net economic return in the current study are neglected because of the time constraint and the difficulty of getting information on operating costs. We therefore, assumed that the cost of operation between small, medium and large vessel are similar. In other words, we assume that the total cost for each type of vessel size is a constant, that is, not a function of catch and hence disappears with the first derivative of the net return with respect to catch.

Collusive simultaneous strategy

Our definition of collusive strategy refers to the equal sharing of output between the small and larger operators. As in the case of two players above the collusion means they come under one management and we are only interested in the evaluation of shared output and the impact it impinges on the economic returns of both parties. We also assume that the species of fish caught by small and medium vessel are homogeneous, that is, catches of these vessels are measured in terms of biomass body weight such as in metric tons. Hence, with this assumption collusion is possible because q_1 is assumed to be equal to q_2 and $q=q_1+q_2$.

$$R(q)_1 + R(q)_2 \; = \; f_1(q_1, q_2)\, q_1 \; + \; f_2(q_1, q_2)\, q_2 \qquad (9)$$

$$TR(q) = \; (a_0 + a_1 q_1 + a_2 q_2) q_1 + (b_0 + b_1 q_1 + b_2 q_2) q_2$$

Since $q_1 = q_2$ the quantity of small vessel can be replaced by the quantity of medium vessel and vice-versa in the above total revenue function yielding the following transformed total revenue $TR(q_1)$ if all q_2 are replaced by q_1

$$\prod(q_1) \; = TR(q_1) - 2C(q_1) \qquad (9.1)$$

$$\prod(q_1) \; = \; (a_0 + a_1 q_1 + a_2 q_1) q_1 + (b_0 + b_1 q_1 + b_2 q_1) q_1 - 2C(q_1) \qquad (9.2)$$

The derivative of the above net economic return function with respect to q_1 and setting the result equal to zero the optimal collusive quantity of small and medium are obtained (in the current analysis total cost are assumed to be a constant).

$$q_1^* = q_2^* = \; \frac{a_0 + b_0}{2(a_1 + a_2 + b_1 + b_2)} \qquad (10)$$

These small and medium vessel catches represent the optimal quantities of collusive strategy and should be substituted into equations (1) and (2) respectively to get estimates their offered prices which can be subsequently be used to calculate net economic returns for the two fishing operators.

Sequential strategy

The sequential strategy utilizes the derived reaction functions of the competing firms, that is, the small and medium vessel operators as players in the game. These reaction functions for the current study are shown in equations (7) and (8). Suppose the small vessel fishermen started first in the marketing of their catches that will be followed by the medium vessel fishermen, the first mover's revenue function becomes

$$R(q)_1 = (a_0 + a_1 q_1 + a_2 q_2)q_1 \quad (11)$$

Replacing q_2 with its RHS identity and rearrange the parameters equation (11) becomes

$$R(q)_1 = a_0 q_1 - a_1 q_1^2 - (\frac{a_2 b_0}{2b_2})q_1 - (\frac{a_2 b_1}{2b_2})q_1^2 \quad (12)$$

$$\prod(q_1) = R(q_1) - C(q_1) = a_0 q_1 - a_1 q_1^2 - (\frac{a_2 b_0}{2b_2})q_1 - (\frac{a_2 b_1}{2b_2})q_1^2 - C(q_1) \quad (13)$$

Differentiating the net return equation above with respect to the quantity of catch of small fishermen q_1 and setting the result to zero (again assumed total cost information is absent) we can obtain the quantity of output of small fishermen as the first mover which should be equal to

$$q_1^{\#} = (a_0 - \frac{a_2 b_0}{2b_2}) / 2(a_1 - \frac{a_2 b_1}{2b_2}) \quad (14.1)$$

$$q_2^{\#} = \frac{b_0}{2b_2} - \frac{b_1}{2b_2} q_1^{\#} \quad (14.2)$$

These optimal quantities of $q_1^{\#}$ and $q_2^{\#}$ can be used to derive the net economic returns for the small size vessel as the first mover and medium size vessel fishermen as the follower after obtaining the efficient prices for the respective operators. Being the first mover we believe the small fishermen are able to benefit from a bigger market potential than the follower who will take to optimize his economic return for the remaining market. This means the follower is left with a smaller market to optimize his/her return therefore smaller chance of profitability.

DATA

Data for this analysis was obtained from the Annual Fisheries Statistics 2004 published by the Department of Fisheries Malaysia, Kuala Lumpur. Prices were reported at the ex shore, wholesale and retail levels and their trends were more or less fluctuated accordingly following the patterns set forth by the original shore prices. There were twenty six fish species selected for the analysis based on the extent of these species caught. We do believe that prices offered to the market follow the law of demand, that is, the more the species of fisheries caught the lower are their prices and vice-versa. Fish species that are scarcely caught will generally fetch better prices than those which are caught in plenty. Based on this assumption the relationship between price and quantity of fish caught is expected to be inversely related.

The catch refers to twenty-six species of fish caught for the year 2004 and they are categorized in accordance with the small, medium and the large vessels. The average price for all species analyzed on shore is RM10.44 per kilogram, wholesale RM12.15 per kilogram and retail RM14.54 per kilogram.

RESULTS AND DISCUSSION

This section is divided into two parts. The first part presents results of the regression analyses using Shazam econometric package. The second part discusses the results of the simultaneous non-collusive and collusive games and the sequential strategies for deciding on a policy that should be most appropriate to improve the condition of for the small fishermen in relation to the medium and large fishermen.

The results of regression analyses of the indirect demand functions for the catch of small vs. medium vessel and small vs. large vessel are presented in Table 1. A high correlation is expected between the prices at the three marketing levels; between ex shore, wholesale and retail prices. This is evidently true since individual fish prices tend to raise in proportion with the marketing levels to which they are sold, that is highest for the retail price and lowest for the ex shore price. High correlation between prices is indicated by the large t-values of regression coefficients of the estimated regression equations.

Table 1: Results of the Regression Analyses for Small, Medium and Large Vessels of West Malaysia 2004

	constant	Ex price (P_1)	Wholesale Price (P_2)	Retail price (P_3)	Small vessel catch (q1)	Medium vessel Catch (q_2)	large vessel Catch (q_3)	R^2	DW
P_1	-0.65952		0.91733		-0.00082			0.999	1.734
	(-7.900)***		(218.0)***		(-1.595)^{NS}				
P_2	0.8448	1.086				-0.0003187		0.999	1.741
	(8.918)***	(203.9)***				(-0.9609)^{NS}			
P_1	-1.5567			0.83016	-0.0001278			0.998	1.753
	(-10.580)***			(124.8)***	(-1.447)^{NS}				
P_3	2.2496	1.1894					-9.038E-05	0.998	1.763
	(12.060)***	(115.8)***					(-1.869)*		

Note: Figures in parentheses denote t values, ***significant at 0.01 * significant at 0.10 & ^{NS} not significant.

Since quantity demanded is inversely associated with the price it therefore, follows the ordinary demand theory of normal goods. Here the quantity caught is assumed to be totally consumed and none of the production is used for export or consumed outside the country. The total quantity of consumption (q_c) should be equal to the total production (q_p) plus import (m) and minus export (x), that is $q_c= q_p+m-x$, since we do not have data on import and export directly related to this study the whole component of fish production is assumed to be consumed. With the exception of the quantity demanded (q_2) and the wholesale price (P_2) for medium vessel the t-values of the demand coefficients are somewhat significant at 90 percent probability level. The regression equations were estimated using Shazam auto command.

These estimated regression equations were used to calculate the reaction curves for the small vs. medium vessel and small vs. large vessel, quantity of catch sold to the market with the help of excel spread sheet. The results of the non-collusive linear interaction functions are shown below,

$$p_1 = 30.5428546 - 0.021700\, q_1^{*} - 0.007736 q_2^{*}$$
$$p_2 = 34.0143401 - 0.023566\, q_1 - 0.008430 q_2$$

$$p_1 = 24.6538254 - 0.010130\, q_1^{*} - 0.005951 q_3^{*}$$
$$p_3 = 31.5728599 - 0.012053\, q_1 - 0.007170 q_3$$

The reaction curves for the non-collusive small vs. medium vessel and small vs. large vessel are as follows:

$$q_1 = 703.75888 - 0.1782495\, q_2$$
$$q_2 = 2016.7108 - 1.3972276\, q_1$$

$$q_1 = 1216.452473 - 0.29363271\, q_3$$
$$q_3 = 2202.176501 - 0.84066954\, q_1$$

Using these reaction curves the non-collusive, collusive simultaneous and the sequential strategies of game theoretic optimal results for small vs. medium vessel and small vs. large vessel are derived and the results of these optimal payoffs are presented in Table 2.

The underlying reasons for choosing to present the results of game in tables instead of the normal payoff metric between players are: *fist*, there may be several criteria that we wish to consider in selecting a particular strategy relative to others. In the game theory players normally choose the equilibrium strategy that yields the best outcomes to both parties. *Second*, the decision to adopt a strategy with the highest return from the players' standpoint may not serve to give the best return to the society's welfare. The society's welfare can be measured in terms of consumers' surplus—the bigger the consumers' surplus the better is the society. *Third*, if the criterion is based on the highest possible return to the economy such as its contribution to the gross domestic product (GDP) then decision would most likely be different under these marketing systems of simultaneous (collusive and non-collusive strategies) and sequential strategy. Bearing in mind that the ultimate policy objective is to help the small vessel size fishermen improve their livelihoods from fishing activities through choosing the appropriate marketing strategy.

If the final outcomes of the game in Table 2 were presented in payoff-metric one can easily spotlight the two potential equilibrium strategies that can help improve small fishermen incomes, that is collusive simultaneous strategy (RM7921.61, RM9037.94) and sequential strategy with F1's as the first mover (RM5124.77, RM9444.29). The small vessel size fishermen expected profit's share would be around 87.6 percent of the medium fishermen profit in simultaneous collusive strategy, and 54.3 percent in sequential F1's first mover strategy. Apparently these results are also evident in Table 2 for the payoff-metric between small and large fishermen (RM9432.75, RM12953.32) and (RM6498.68, RM11309.41) for simultaneous collusive strategy and simultaneous F1's as the first mover respectively. The corresponding profit's shares of the small to large fishermen are 72.8 and 57.5 percent.

Merger was found to be profitable depending on cost and the market structure (Steffen and Konrad 2001). Merger would benefit in terms of economic of scale, however, it should be aware that for every merger there is a possibility of blending the different levels of efficiency achieved by the merging firms. The larger firm with better profitability will have to sacrifice to smaller firm in terms of providing expertise and skills, sharing facilities for research and development, and perhaps training the new partner's personnel to keep up with the dominant firm's know how. Although it is possible for the smaller firm to excel in certain fields such as in management because of its small unit, generally the larger firm will have to bear the burden of merging. This is apparent from table whereby profits of medium and large firms have reduced significantly under collusion relative to their non-collusion condition.

Steffen et al. (2001) also found that Stackelberg beats Cournot on collusion and efficiency in experimental markets in terms of higher outputs. Our results seem to mach that of Steffen and Normann (ex. q_1=525.4 & q_2=525.4 metric tons for Cournot versus q_1= 685.96 & q_2 =1058.3 metric tons for the F1's first mover Stackelberg) as shown in both of Table 2. Since we used profits as the final payoffs the large quantity of output will result in lower efficient price. The Stackelberg model is still superior to Cournot if F2's is the first mover in the sequential strategy. For all model the Steckelberg sequential model is generally superior to Cournot in terms of society's welfare since consumers' surplus for this model is highest by virtue of its lowest efficient price compared to other models considered in this study. Since the demand function is linear we can easily estimate the value of the consumers' surplus. The massage here is that if the society's welfare--the consumers, is of paramount importance in policy formulation than the individual's firm, the Steckelberg's sequential model is most appropriate. The collusive strategy, in most cases tends to impose high efficient price because of the reduction in quantity demanded.

Steffen and Konrad (2003) found that although merger "typically creates complex organizations, it has a more profound effect on the structure of a market than simply reducing the number of competitors." According to them horizontal merging is profitable and welfare improving if costs are linear. Moreover, merger is preferred because of the presumption that information and decision makings flow more freely and commitment is high within the merging firms.

Finally, for a policy that favors the largest economic return to the economy as the ultimate goal we found the non-collusive simultaneous strategy is most appealing (Tables 2). Under competitive market the dominant firms are free to choose the level that suit them best and the consideration for the smaller firms which are less dominant will have to bear the consequence of inefficiency in competition. Output ratio for the small to medium fisher is around 22.4 percent while their profit ratio is slightly lower, that is 19.4 percent. The same figures for small to large vessel fishermen were 48.3 percent and 33 percent for output and profit ratios respectively.

CONCLUSION

This paper deals mainly with the parametric application of the game theory namely the non-collusive, collusive simultaneous and the sequential strategies in the marketing of small, medium and large vessel fishermen's outputs. The results evidently support merger for the small fishermen because of the economic of scale and the level of efficiency between the merging firms are different. The possibility of blending different levels of efficiency achieved by the merging firms gives rise to the problem of adjustment. Merging benefits the smaller firm, in terms of the dominant firm's know how--its expertise and skills, facilities for research and development, and perhaps training of the new partner's personnel. There is a trade-off, in that the dominant firm's profitability will be reduced while the small firm increases. Although merger typically creates complex organizations, it has profound effect besides reducing the number of competitors, merger is preferred because information and decision makings flow more freely and commitment is high within the merging firms.

However, the Steckelberg sequential model is generally superior to the Cournot collusive strategy if the goal of the policy maker is to increase the society's welfare since consumers' surplus for this model is highest by virtue of its lowest efficient price. If the policy goal is to improve the small firm's profitability then it would be more appropriate to concentrate on collusive simultaneous and sequential with F1's (small firm) as the first mover. If the policy goal aims at the largest economic return to the economy then using linear models we found the non-collusive simultaneous strategy is most appealing.

The present study assumes that fishermen market their daily catch without any strategic knowledge of game theory such that there is no association whatsoever between the way they market their catches and the profitability. It is further assumed that the market is constrained from inland fish suppliers and the market is completely dependent on local fishermen. Consumers would generally prefer fresh landings to the storage supplies of previous day catches. As the current economic model of game theory uses secondary data it would therefore be necessary to support these findings with empirical investigation using primary data and real world observations. Further study should be focused on the possibility of extending this steady-state to the intertemporal analytical framework.

REFERENCES

Holt C. A. and Roth A. E., 2004. The Nash equilibrium: A perspective, *PNAS* march 23. vol. 101 (12), pp. 3999-4002

Neumann J. von and Morgenstern O. 1944, *The Theory of Games and Economic Behavior*, Princeton, N.J. : Princeton University Press.

Nicholson W., 1997. *Intermediate Microeconomics and Its Application* (Seventh Edition). Fort Worth Philadelphia, the Dryden Press, Harcourt Brace Collage Publishers, pp. 345-347.

Pindyck, Robert S. and Daniel L. Rubinfeld , 2006. *Microeconomics* (six edition) Pearson prentice Hall (chapter 13).

Stanford Encyclopedia of Philosophy (revised version March 10, 2006) http://plato.stanford.edu/entries/game-evolutionary/#1

Steffen, Huck and Kai Konrad, 2003. Strategic trade policy and home bias in firm ownership structure*, Japan and the World Economy*, Elsevier vol. 15(3). Pp. 299-305, August.

Steffen, Huck, W. Muller, H. Norman, and Hans-Theo, 2001. Stackelberg beats Cournot-on collusion and efficiency in experimental markets, *Economic Journal*, Royal Economic Society, 111(474), pp. 749-65.

Steffen, Huck and Kai Konrad, A., 2001. *Economic Letters* 73 (2), pp. 213-217.

Table 2: Catch, Return and Price of Small, medium and Large Fishermen under Strategic Games in Marketing West Malaysia 2004.

	Non-Collusive	Collusive	Sequential Strategy		Non-Collusive	Collusive	Sequential Strategy	
	Simultaneous	Simultaneous	Small Fishermen First Mover	Medium Fishermen First Mover	Simultaneous	Simultaneous	Small Fishermen First Mover	large Fishermen First Mover
Catch of small vessel Q1 (t)	344.3	525.4	685.9	336.7	756.6	796.3	1125.5	532.4
Catch of medium vessel Q2 (t)	1535.7	525.4	1058.3	2059.0				
Catch of Large vessel Q3 (t)					1566.1	796.3	1,256.0	2,329.70
Ex price of small fisher P1 (RMy per kg)	11.19	15.08	7.47	7.31	7.67	11.85	5.77	5.39
Wholesale price of medium fisher P2 (RMy per kg)	12.95	17.2	8.92	8.71				
Retail price of large fisher P3 (RMy per kg)					11.23	16.27	9.00	8.46
Return of small fisher π1 (RMy)	3,853.24	7,921.61	5,124.77	2,460.63	5,800.58	9,432.75	6,498.68	2,872.04
Return of medium fisher π2 (RMy)	19,887.73	9,037.94	9,444.29	17,943.89				
Return of large fisher π3 (RMy)					17,583.00	12,953.32	11,309.41	19,699.15
Q1/Q2	0.224	1.000	0.648	0.164				
Q1/Q3					0.483	1.000	0.896	0.229
π1/π2	0.194	0.876	0.543	0.137				
π1/π3					0.33	0.728	0.575	0.146