Participation in Vessel Buyback Programs: An Option Value Model of the Vessel-Scrapping Decision

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ABSTRACT

This paper develops an option value model to examine vessel owners in deciding to participate or not in the vessel buyback program. The model accounts for the uncertainty generally involved in a decision to retire an aged vessel and the underlying value of waiting for new information about the profitability of such a change, which may substantially affect the willingness to participate in the vessel buyback programs. The results indicate that policy makers have many factors to be concerned with uncertainty as this value of waiting may be so great as to invalidate any vessel buyback program that do not take it into account. This also contributes to explain the failure of most of the vessel buyback programs aimed at encouraging the retirement of aged vessels in Taiwan. In addition, the lowest threshold value of the willingness to accept is estimated and its policy implications is also discussed.

Keywords: Real options, Vessel buyback program, Willingness to accept, Net profit uncertainty, Option Value Model

I. Introduction

Overcapitalization and overcapacity in the fisheries have been found in recent years, Mace (1997) points out in her address during the World Conference on Fisheries that as much as 70% of world's fisheries are in different degrees of stress (fully exploited, over exploited, or in recovery). Concerning with this fact and its impacts on fish stocks has reported in the literature (FAO, 1997), the policy of prohibited restriction in building new fishing vessels without quota has been continuously taken in effect in Taiwan. According to the data showing to the end of 1990, the number of the powered fishing vessels, which have been operated more than 15 years, the number has reached 4,824, which occupies 35% of the total vessels. Because low efficiency in fishing industry as well as diminished revenue, the smuggling activities led to the management problems in society security and fisheries. In order to improve this phenomenon by Fisheries Administration, it has carried out old vessels buyback program for 5 years from 1991 to 1995; it has been purchasing 2,337 fishing craft by NT$12,000 per ton for each one. However, the effects of vessel buyback program cannot reach the estimated goal of 10,000 powered fishing vessels. This is due to the fact that the boat owners who are unwilling to retire those aged fishing vessel automatically, which made the desired effects unsuccessfully (Dai, 1997).

Therefore, the purpose of this article is to discuss how the boat owners decide to retire the aged fishing vessels. Utilization of the ideas of "Real Options", this paper basically analyzes under the net profit uncertainty in fishing operation and how the boat owners are willingly to give up aged vessels because of the uncertain waiting value. As a result, this can explain why the plan of vessel buyback program from the government achieved less; for example, 96 fishing crafts represent 0.72% of total number of vessels in 1995. In those related reference, the outcomes of vessel buyback program policy, Holland, Gudmundsson and Gates (1999) indicated that the plan of buying back the fishing fleets from government is usually unable to achieve effectively to the purpose of solving the fisheries problems. However, they do not explain the reason why this buyback policy is unsuccessfully with the theory. Recently, Li (1998) has used the model of Option Value, analyzing that the mutual cooperated fishing proprietors will become more reserved in their fishing actions in order to elevate their efficiency in fishing under the uncertainty of fishing resources stock, meanwhile, there are no another fishing fleets entering into the fishing ground. Chuang (1999) also suggested to set up a discontinuous Option Model to evaluate the buyback plan of Taiwanese fishing fleets, pointing out the connection between the economic variance and the fishing vessel value from the structure of the buyback motive, which can achieve the buyback goal effectively. Sun (1998) estimated Maximum Sustainable Yield (MSY), Maximum Economic Yield (MEY), and Optimum Yield (OY), also examining the outcome of less fishing fleets' plan in 1998. His research focused on the effort of descending the fishing in order to recover the fishing stock in current Taiwanese coastal fisheries. Moretto (2000) applied the idea of Real Option and set up the stochastic to analyze the plan of the retirement in aged vehicles by the owners. Upon considering the circumstances of uncertainty in the labor service net profit in vehicles, the owners of vehicles would wait for the net profit information, which has been produced the waiting value to decide the period of retirement. The above-mentioned references have been done further research for aged

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vessel retirement policy in experimental analysis as well as the discussion of theoretical model.

This paper applies a Real Option Model which has been developed by Dixit (1993), Dixit and Pindyck (1994), Trigeorgis (1999), and Moretto (2000), setting up a stochastic model of vessel retirement policy, also affected the retirement policy from the owners under taking into consideration for the uncertainty of waiting value. At the same time, it also led the boat owners to accept the Willingness-to-accept (WTA) amount of buyback aged vessel program, and explained the reason why the plan of buyback aged fishing vessels from government cannot be accomplish effectively, maybe because the uncertain fishing net profit caused the waiting value, which made the owners postpone their willingness of retired aged vessels. The structure is set up as follows: next section develops a stochastic policy model of retirement aged vessels and the analysis of the retirement policy from the boat owners as well as the impact factor, such as waiting value of vessel owners and vessel purchasing price of WTA, and the amount of buyback aged vessels from government are derived in section III; Section IV is numerical simulation analysis and conclusion in the final section.

II. The Buyback Program in Taiwan

Background

The government of Taiwan has invested heavily in the fishing industry to boost its commercial fishing fleet since the 1950s[1]. In Figure 1 we use four indices to represent fishing industry capacity including number of boats, tonnage, horse power, and total landing. Using 1970 as the base year, the index numbers are the ratio of the quantity of each measure for a year to that of the base year, respectively. Technological improvement in engine design causes the total horse power to rise sharply. The discrepancy in growth rate between number of boats and tonnage implies that larger vessels made of steel are replacing wooden vessels in recent years. The stimulation policy adopted by the Taiwan government greatly increased fish landing till the late 70s. The recent trend in landing seems to suggest that growth of the fishery industry may have begun to exert pressure on fish stocks.

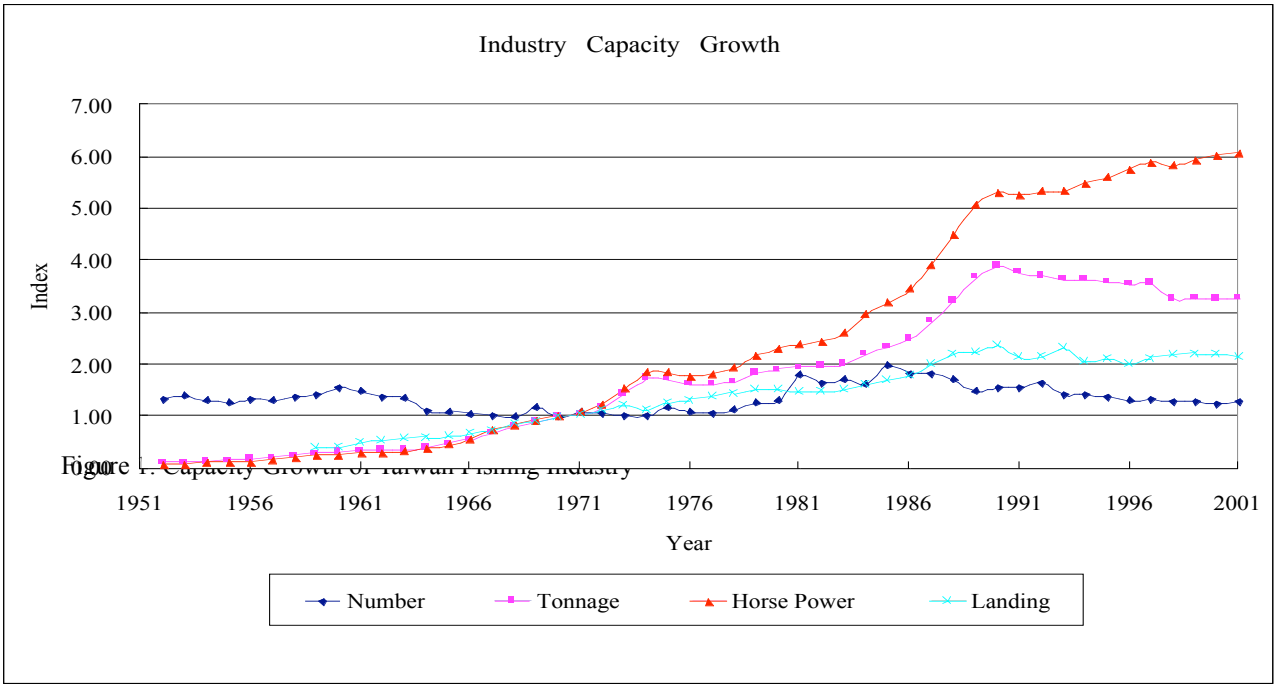


Figure 1. Capacity Growth of Taiwan Fishing Industry

In response to decline in the profit of fishing operations, in 1991, 3 billion NT dollars was appropriated to implement a five year (1991-1995) buyback program in an effort to reverse the trend of excessive capitalization and growth[2]. The program was designed to achieve multiple purposes besides reducing fishing capacity and protecting fishing resources. First, decreasing profits had turned many fishing vessels to smuggling and other illegal activities which the program was expected to curtail. Second, the buyback program in its second year targeted high seas drift net vessels to comply with the UN resolution banning their use[3]. Third, the buyback program was expected to accelerate the salvage of old

[1] Low interest loans were provided to fishermen for upgrading vessels and procuring equipment. A substantial fuel subsidy was implemented to cut operating costs and increase profits. These measures have stimulated the industrial capacity.

[2] Taiwan government issued a directive at the 6th National Security Convention held on October 8th, 1990 to control the number of vessels through a buyback program.

[3] In order to comply with international fishery protection activities, gill net of large mesh size and squid gill net have been forbidden in Taiwan since 1993.

boats and reduce congestion and enhance the amenities in fishing harbors.

The buyback program was publicized each year for a period of twenty days for the first year and thirty days thereafter to inform the fishermen. Applicants were then required to register at the fishery department of county authority. Application was then submitted to the Council of Agriculture for approval. However, no historical catch records or revenues were used for screening. The approved vessels along with their licenses were turned over to the local government. They were then scrapped; the ones made of woods were burned and those made of steel or FRP were submerged to form artificial reefs. Details of operational procedures for the buyback program as follows (Figure 2):

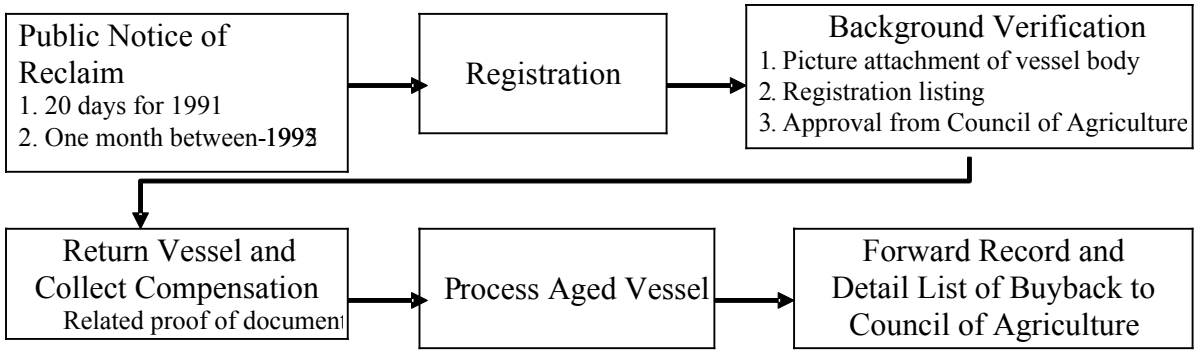


Figure 2 Operational Procedures of the Buyback Program

Different criteria were applied to target specific types of vessels. For 1991-1992, all vessels were eligible for the program as long as the owner had a legal fishing license. In 1993, only boats at least 15 years old could apply for the program. In 1994, vessel age for eligibility was lowered to 12 years due to low participation. In addition to eligibility criteria, priorities were also set for different ages and types. In 1991, vessels older than 20 years were given the highest priority. Older drift-net boats were given higher priorities next year to comply with the UN resolution banning their use. In 1993, priorities were assigned to assure that active boats were bought back. Captains with licenses that had expired before Nov. 17, 1990 were assigned the third priority if they agreed to not engage in fishing anymore. Similar schemes were also adopted in 1994.

Program Results and Its Impact on Resource Conservation

Taiwan government spent $NT 1.873 billion of a total of 3 billion budget to implement the five years program. Ninety one percent of the total spent money was used to purchase vessels, about 8% on deactivating the purchased vessels and 1% on administration management. Tables 1 to 4 summarize the total number and percentage of boats bought in each key administrative region broken down by year, type of boat, vessel age, and fishing categories. Table 1 shows that the majority of the vessels were bought back in the first three years. The rate of program prosecuted varies significantly over geographic regions as shown by the Chi-square test. Because the program targeted aged vessels, about 90% of vessels bought back were 15 years old or older except in Keelung where 40% of the boats were between 12 and 15 years old (Table 2). In terms of body type, the majority of vessels were wooden because of their low salvage value (Table 3). The total number of boats reclaimed was 2,337 equivalent to about 15 percent of the total number of powered vessels in 1990 before the program started. Table 4 shows that number of vessels bought are similar between net fishery and line fishery while net fishery has more tonnage than line fishery. Trawl net and long line are major two fishing categories participating in this buyback program. According to Taiwan Fisheries Bureau, reclaimed parking space for vessels in fishing harbors are estimated 119,983 square meters. Among total buyback vessels, there were 340 vessels (335 of total 461 buyback steel vessels and 5 of total 9 buyback FRP vessels) weight total 60,170.4 tons submerged in 14 regions as artificial reef, which estimated provide 60 thousand cubic meter fishing ground.

Table 1. Aggregate Number and Percentage of Vessels Bought Back

County Name	Number Reclaimed					Percent of Total Industry Fleet Size				
	1991	1992	1993	1994	1995	1991	1992	1993	1994	1995
Keelung	66	29	95	50	20	4.52	2.07	6.86	4.07	1.70
Ilan	170	87	81	30	6	9.44	5.30	4.72	1.80	0.36
Taipei	37	36	28	5	8	2.38	2.40	1.94	0.41	0.63
Kaohsiung Hsien	26	33	23	3	1	3.55	4.50	3.18	0.41	0.14
Pingtung	71	74	27	6	6	3.54	3.84	1.43	0.32	0.31
Penghu	230	132	58	5	3	6.53	4.03	1.81	0.17	0.11

Kaohsiung City	197	169	181	60	38	6.05	5.60	6.53	2.33	1.52
Other	77	54	34	52	14	5.67	4.36	3.04	4.79	1.18
Total	874	614	527	211	96	5.57	4.17	3.69	1.59	0.72
Chi-Square *	113.50	48.77	180.93	202.69	66.86					

Source: Report on Results of Aged Vessel Buyback Program 1991-1995. Taiwan Fisheries Bureau, Department of Agriculture and Forestry, Provincial Government of Taiwan, 1993-1997.

Note: *Chi-square statistic for testing null hypothesis that all eight counties number of vessel purchased is jointly equal.

Table 2. Number of Vessels Bought by Vessel Age

County Name	Number of Boats			Percentage of Total Reclaimed		
	Age>20	15<Age<20	12<Age<15	Age>20	15<Age<20	12<Age<15
Keelung	55	107	98	21.15%	41.15%	37.69%
Ilan	203	125	46	54.28%	33.42%	12.30%
Taipei	63	36	15	55.26%	31.58%	13.16%
Kaohsiung Hsien	62	21	3	72.09%	24.42%	3.49%
Pingtung	106	77	1	57.61%	41.85%	0.54%
Penghu	312	104	12	72.90%	24.30%	2.80%
Kaohsiung City	330	242	73	51.16%	37.52%	11.32%
Other	144	88	14	58.64%	35.77%	5.69%
Total	1275	800	262	54.56%	34.23%	11.21%

Source: Report on Results of Aged Vessel Buyback Program 1991-1995. Taiwan Fisheries Bureau, Department of Agriculture and Forestry, Provincial Government of Taiwan, 1993-1997.

Table 3. Number and Percentage of Vessels Bought Back by Body Type

County Name	Number of Boats			Tonnage			Total	
	Wooden	Steel	FRP	Wooden	Steel	FRP	Number	Tonnage
Keelung	75 (28.85%)	183 (70.38%	2 (0.77%	1187.96 (5.42%)	20705.04 (94.40%	39.65 (0.18%)	260 (11.31%)	21932.65 (18.53%)
Ilan	335 (89.57%)	38 (10.16%	1 (0.27%	4888.67 (51.17%)	4537.76 (48.00%	28.16 (0.30%)	374 (16.00%)	954.59 (7.99%)
Taipei	105 (92.11%)	6 (5.26%	3 (2.63%	1262.35 (65.24%)	569.33 (29.42%	103.24 (5.343.3%	114 (4.88%)	1934.92 (1.63%)
Kaohsiung Hsien	86 (100.00%)	0 (0.00%	0 (0.00%	1226.03 (100.00%)	0.00 (0.00%	0.00 (0.00%)	86 (3.68%)	1226.03 (1.04%)
Pingtung	184 (100.00%)	0 (0.00%	0 (0.00%	2582.21 (100.00%)	0.00 (0.00%	0.00 (0.00%)	184 (7.87%)	2582.21 (2.18%)
Penghu	416 (97.20%)	12 (2.80%	0 (0.00%	7548.59 (77.90%)	2141.58 (22.10%	0.00 (0.00%)	428 (18.31%)	9690.19 (8.19%)
Kaohsiung City	424 (65.74%)	220 (34.11%	1 (0.16%	884932 (13.06%.)	58836.38 (86.83%	78.45 (0.12%)	645 (27.60%)	67764.15 (57.56%0

Other	242 (98.37%)	2 (0.81%	2 (0.81%	3563.79 (95.54%)	153.27 (4.07%	52.50 (1.39%)	246 (10.53%)	3769.56 (3.18%)
Total	1867 (79.89%)	461 (19.73%	9 (0.39%	31108.92 (26.38%)	86943.36 (73.46%	302.02 (0.26%)	2337 (100%)	118354.30 (100%)

Source: Report on Results of Aged Vessel Buyback Program 1991-1995. Taiwan Fisheries Bureau, Department of Agriculture and Forestry, Provincial Government of Taiwan, 1993-1997.

Table 4. Number and Ton of Vessels Bought by Fishing Categories

District	Total		Net Fishery				Line Fishery				Others	
			Total		Trawl Net		Total		Long Line		Total	
	No.	Ton	No.	Ton	No.	Ton	No.	Ton	No.	Ton	No.	Ton
Keelung	260	21932.7	223	21034.3	184	20557.4	36	889.1	33	868.9	1	9.2
Ilan	374	9454.6	55	4104.3	45	3561.9	285	4923.3	274	4771.6	34	427.0
Taipei Hsien	114	1934.9	68	1217.8	5	490.7	41	682.4	41	682.4	5	34.7
Kaohsiung Hsien	86	1226.0	48	662.5	15	166.6	38	563.5	38	563.5	0	0
Pingtung Hsien	184	2582.2	28	504.6	14	220.0	156	2077.7	145	1995.7	0	0
Penghu Hsien	428	9690.2	359	5668.0	83	2561.3	68	3996.6	68	3996.6	1	25.6
Kaohsiung City	645	67764.2	216	31925.7	192	31095.6	429	35838.4	425	33880	0	0
Others	246	3769.6	158	2647	29	777.8	70	931.4	63	901.9	18	191.7
Total	2337	118354.4	1155	67764.2	567	59431.3	1123	49902.4	1087	47660.6	59	688.2

Source: Report on Results of Aged Vessel Buyback Program 1991-1995. Taiwan Fisheries Bureau, Department of Agriculture and Forestry, Provincial Government of Taiwan, 1993-1997.

Application in vessel buyback programs is usually voluntary, vessel owners evaluate the total benefits offered by the program and choose to give up a vessel and fishing license as they see fit. The opportunity cost of selling the vessel is simply the profit that could have been realized if the vessel continues its fishing operation. For a rational individual, the comparison of the opportunity cost and the program benefit determines the decision. If the buyback offer is greater than the profit that a vessel can generate over the remainder of its life, the vessel owner will forgo the vessel and participate in the program, and vice verse. In reality, an effective vessel buyback program needs careful design and implementation. The vessel buyback program of Taiwan was well funded and the program had opportunities for revision and improvement during its five-year run. In this study, we examine the economic incentives for vessel owners to apply the vessel buyback program. Among the 108 full-time vessel owners who engage in commercial and recreational fisheries, only 25 of the responds think that the buyback scheme is reasonable. Referring to Table 5, the minimal price acceptable for the vessel buyback program is NT$12,000 which was designed price by government. Following the introduction of this buyback program, a market for such vessel trade is created since the total tonnage is limited and new entry is prohibited in 1989 unless permit transfer from old vessel. The highest price is for line fishery vessel between 10-20 tonnage, average NT$28,5000, vessels of this category are sold to be market for recreational fishing vessels. However, the lowest price is for net fishery vessel between 0-5 tonnage, average NT$ 16,750, vessels of this category are heavily trade in the market. The overall average acceptable incentive for applying in the vessel buyback program is NT$24,375 which is well above the NT$12,000 buyback price.

Table 5. Respondent's Feedback on Buyback Program and Intention to Participate

Tonnage of Vessel	Is NT$12,000 Per Ton Reasonable			Acceptable Incentive for Participation in Buyback Program						Participant in Buyback Program
				Net Fishery			Line Fishery			
	Yes	No	Total	Min. (NT$)	Max. (NT$)	Ave. (NT$)	Min. (NT$)	Max. (NT$)	Ave. (NT$)	
0- 5	4	16	20	10,000	25,000	16,750	12,000	28,000	22,500	6
5-10	11	24	35	16,000	35,000	21,750	18,000	40,000	26,500	10

10-20	6	28	34	15,000	40,000	25,000	16,000	50,000	28,500	9
20-50	4	15	19	12,000	30,000	19,500	16,500	25,000	21,000	7
Total	25	83	108	10,000	40,000	21,750	12,000	50,000	24,375	32

Source: These surveys were conducted in June and October 1998 respectively.
Note: Net fishery includes trawl net, gill net, purse seine, torch light, and large scale; line fishery includes long line, pole and lines boote, squid jigging, and troll line.

III. Stochastic Model

Whether vessel owners accept the buyback aged vessels conditions offered by Fisheries Administration to retire aged vessels; from the point of view of real option, vessel owners have the right but no obligation to accept the conditions of buyback. The policy decisions would depend on the degree of "Deep in the money". If we assume in a specific fishing industry, all of the vessel owners are willing to cooperate to work out the fishing retirement policy in the industry. So, the sense of mutual cooperation will lead to Community fisheries co-management system so that we are able to take this mutual cooperation policy behavior as a boat owner who has purchased a fishing boat after a suitable period of time, then retire an aged one to replace the same model of new one. This recycle formed for the period of owing a boat will be assumed as much more infinite recycle in simplified analysis, which shows that the time level for owners' decision policy is infinite. This assumption is combined with the basic assumption from both Li (1998) and Morreto (2000), who would take the aged vessel retirement behavior from the owners as the retirement behavior of real asset investment, also pay attention to the developing trend of Community fisheries co-management in fisheries industry. As a matter of fact, Munro also indicated that it would be workable in the practice of Community fisheries co-management system in his research.

Similar to Moretto's research (2000), the fishing net profit π per every time unit can be described with Geometric Browian motion as:

$$d\pi_t = \alpha\pi_t dt + \sigma\pi_t dw_t, \quad \alpha \geq 0, \quad \pi_0 = m \tag{1}$$

Here, dw_t is the increasing volume in Standard Wiener process, $E(dw) = 0$ and $E(dw_t^2) = dt$. $\alpha \geq 0$ is the expected growth rate of (the trend value of stochastic process), σ is standard deviation of per unit time growth rat. Thus, equation (1) indicates that the fishing fleet net profit of vessel owner has been known when the time period is zero, which shows the net profit from the new vessels is m. However, the growth rate of π_t through time is uncertain. As a matter of fact, in accordance with the proof from McDonald and Siege (1986), π_t is Log-normally distributed and its mean is $E_0(\pi_t) = me^{\alpha t}$. Therefore, the expected net profit of owners will be decreased in accordance with the year of vessels' operation. As to the reason of net profit uncertainty that comes from the external random assault; for example, the fishing environmental factor caused increased risks in fishing operation, or the marketing factors led to the increased fishing cost and the falling-off fishing cost, or the depleted in fish resources also caused the uncertain fishing of owners, those factors all influence the owners' net profit π_t.

Now, because the consideration made us to decide the suitable fishing retirement policy for the infinite continuously recycle for the owners, the fishing net profit status will be $\pi_t = \pi$ in the period of t for owners, and the estimated net profit value in the period of owing fishing fleet for owners will be

$$F(\pi) = \begin{cases} \int_t^{\infty} \pi_s e^{-r(s-t)} ds - \sum_s C e^{-r(s_i-t)}, & \pi_t = \pi \end{cases} \tag{2}$$

In equation (2), where C is in the t time period, it shows the net profit of buying new fishing vessel for boat owners that is to select a threshold value b to maximize the equation (2). ……

Following Dixit and Pindyck (1994) and Dixit (1993), under the condition of $\pi \in [b, \infty)$, it will obtain $F(\pi)$ through the following second order differential equation:

$$\frac{1}{2}\sigma^2\pi^2 F''(\pi) + \alpha\pi F'(\pi) - rF(\pi) = 0 \tag{3}$$

the frontier condition is $F(\infty) = 0$, and the general solution is

$$F(\pi) = G\pi^{\beta_1} + D\pi^{\beta_2} + \frac{\pi}{r - \mu} \quad (4)$$

where, $\beta_1 > 0$, $\beta_2 < 0$ are roots of Brown's fundamental quadratic

$$\psi(\beta) \equiv \frac{1}{2}\sigma^2\beta(\beta - 1) + \mu\beta - r = 0 \quad (5)$$

In order to make F(π) has the fixed estimated value when π is approaching to the maximum value, $G\pi^{\beta_1}$ must be zero. In equation (4), $\frac{\pi}{r - \mu}$ is the net present profit value of owner to keep a vessel; $D\pi^{\beta_2}$ represents the net profit of cycling purchase vessel and must be positive value. In order to determine the lowest value of constant D and net profit, we have to consider the following conditions such as

(a) Value matching condition:

$F(b) = F(m) - C$, and

(b) Smooth pasting condition:

$F'(b) = 0$

The value matching conditions are indicated in switching the period of new and old fishing fleets, the owners will have the same evaluation to either old or new vessels when they faced the decision making in the suitable retirement conditions. In addition, it needs to meet the first order condition of equation (2), and thus following two equations need to be solved:

$$D\left(b^{\beta_2} - m^{\beta_2}\right) = \frac{m - b}{r - \mu} - C \quad (6)$$

$$D\beta_2 b^{\beta_2} + \frac{b}{r - \mu} = 0 \quad (7)$$

Since $\frac{\pi}{r - \mu} > 0$, D>0 is required to satisfy equation (7). Based on this result and the condition of m>b, we obtain $m - C(r - \mu) > b$. Assume $b^* = m - C(r - \mu)$, here b* value means under the certainty of net profit, the net value occurred form purchasing a new vessel, i.e. the net profit minus the opportunity cost $C(r - \mu)$ of investment; it is clear that under the certainty of net profit, if the net profit π of vessel reaches the value of b*, boat owner will purchase new vessel. However, if the net profit is uncertain, then we have b*>b, In other words, under the conditions of net profit uncertainty, whether vessel owners want to purchase the new vessels, it will depend on the net profit π if it has reached to the value of b. Therefore, under the conditions of net profit uncertainty, vessel owners will wait for obtaining much more information about aged vessel net profit before they decide to purchase any new vessels; then they will make a decisive policy to buy the new ones.

That is because the policy norm is the value of b instead of the value of b*, which means the waiting value is $W = b^* - b = m - C(r - \mu) - b$. Obviously, the waiting value for owners comes from the parameter value in the model under the conditions of net profit uncertainty.

IV. WTA of Vessel Owners and Government Purchasing Price

In this section, we analyze how government offers vessel owners a buyback aged vessel program to encourage the retirement of aged vessels under the cycled period as boat owners still own their vessels. Here, we use $F(b)$ which represents the owner's expected net present profit value of giving up aged vessel, while $F(\pi)$ is owner's current net present profit value and $\pi \in [b, \infty)$. Therefore, in order to induce owners who have got the net profit up to $\pi \in [b, m)$ to accept the aged vessel buyback program offered by the government, trying not to wait for the net profit π up to the value of b, then accepting the buyback aged vessels program from the government so the amount of buyback R must.

$F(b) + R = F(\pi)$, or $R \geq F(\pi) - F(b) \equiv U(\pi, b)$ (8)

In equation (8), $U(\pi, b)$ is the WTA for owner to accept the government buy-back program, and this WTA is related to exist vessel's net profit π, uncertain degree of net profit σ, new vessel's purchasing cost C, discount rate r, and the trend value of σ. Through calculation, equation (8) can be rewritten as

$$U(\pi, b) = D(\pi^{\beta_2} - b^{\beta_2}) + \frac{1}{r - \alpha}(\pi - b) \tag{9}$$

From the observation the equation (9), we can know when the fishing fleet net profit reach to the value of b, $U(b, b) = 0$; at that time, only if the buyback amount offered by government, the fishing fleet owners are sure to give up their aged vessels. As a matter of fact, even if the vessel owners have not accepted the conditions of buyback aged vessels plan, they will be making a decision to buy new fishing fleets. On the other hand, if the fishing craft is new or the external factor such as smuggling activities or selling the fishing fleet oil, will cause the net profit to be π = m, and then $U(m, b) = C$. Meanwhile, we also see when $\sigma \to 0$, that is the fishing fleet net profit is under certain situation, we can revise WTA as follows:

$$U_{\sigma \to 0}(\pi, b^*) = \frac{1}{r - \alpha}(\pi - b^*) \tag{10}$$

and

$$U_{\sigma \to 0}(b^*, b^*) = 0 \text{ Èy } U_{\sigma \to 0}(m, b^*) = C \tag{11}$$

According to equations (9) to (11), we can obtain the following results:

(1) By the impact of net profit uncertainty, the ship owners are getting more interested in taking part in buyback aged vessel program from their WTA because of $U(\pi, b) > U_{\sigma \to 0}(\pi, b^*)$, which forced their willingness to replace new fishing fleets in a slow pace so that the aged vessel program from the government is hard to achieve the expected effects.

(2) The buyback amount of aged vessel from the government should be between [0, ***C***]. And we are sure that the amount is related to the net profit level π_t for ship owners in the time period of t.

V. Numerical Simulation

For the purpose of analyzing how the net profit uncertainty affect the WTA, we can assume three uncertain factors σ =0(net profit is certain), σ =1 and σ =10; r=0.05, α =-0.5, C=100,000, then use equations (5), (6) and (7), we can get value of β_2, D and b. Finally, substitute these value into equation (9), we obtain the relative equations (12), (13) and (14) of WTA and net profit.

1. when σ =0, we have β_2 =-1, D = 74,967,890,560, b = 86,584

$$U(\pi, 86584) = 74967890560(\pi^{-1} - 86584^{-1}) + 10(\pi - 86584) \tag{12}$$

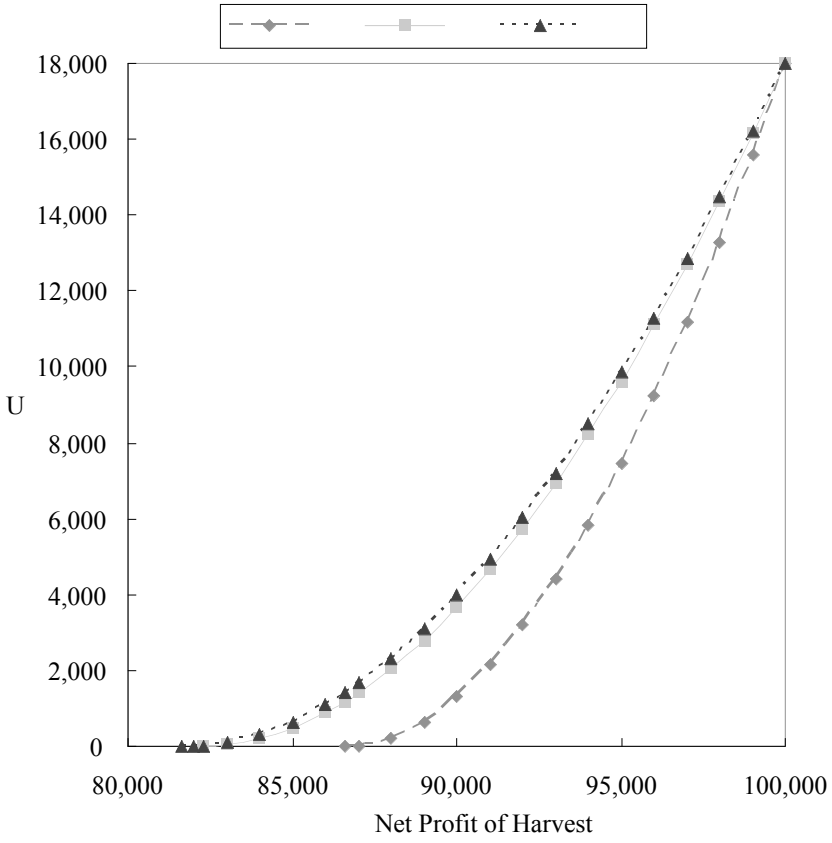
2. when σ =1, we have β_2 =-0.0844, D = 25,345,114, b = 82,296

$$U(\pi, 82296) = 25345114(\pi^{-0.0844} - 86584^{-0.0844}) + 10(\pi - 82296) \tag{13}$$

3. when σ =10, we have β_2 =-0.001_D = 825,736,578_b = 81,645

$$U(\pi, 81645) = 825736578(\pi^{-0.001} - 81645^{-0.001}) + 10(\pi - 81645) \tag{14}$$

Applied different net profit of vessel to equations (12), (13) and (14), we can get results as shown in Figure 3. From figure 3, we can observe the fact, which shows the increased σ, the amount of WTA would be increased accordingly because when the situation gets worse in net profit uncertainty, the waiting value will be higher than expected. As a result of this, ship owners will be slowing down their willingness for the involvement in buyback aged vessels program so that the amount of buyback aged vessels from the government should be increased to encourage ship owners to give up their aged vessels voluntarily.



U	U		
	=0	=1	=10
81,645			0
82,000			5
82,296		0	21
83,000		32	101
84,000		189	316
85,000		471	649
86,000		877	1,095
86,584	0	1,169	1,408
87,000	20	1,402	1,653
88,000	228	2,046	2,320
89,000	656	2,803	3,094
90,000	1,297	3,673	3,972
91,000	2,143	4,652	4,951
92,000	3,188	5,738	6,030
93,000	4,426	6,928	7,206
94,000	5,851	8,221	8,478
95,000	7,456	9,613	9,843
96,000	9,236	11,103	11,299
97,000	11,185	12,689	12,845
98,000	13,298	14,368	14,478
99,000	15,571	16,139	16,197
100,000	17,999	17,999	18,000

Figure 3 Impact on Uncertain Factors to WTA

VI. Conclusion

Based on the analysis from this paper, under the net profit uncertainty of ship owners, the ship owners would put off their decision of taking part in vessel buyback program. As a result, when the government makes a decision in the amount of buyback program, it should consider not only the operation year for fishing fleets, but also the managing situation variance of ship owners. For example, the ship owners' net profit level is also the same as the capability of making a profit and situation for aged vessels, which shows the residue of aged vessels and the investment cost for fishing fleets. Under those circumstances, the buyback amount from the government should match the ship owners' WTA.

In addition to the net profit uncertainty for ship owners, the government should find out what are the reasons that cause this kind of uncertainty situation. If the government can hold steady net profit for ship owners, then they will have more lure motive as well as the lower waiting value to join the buyback vessels policy from the government. Therefore, when facing the uncertain situation in running their industry, the first thing to do is to stabilize the ship owners' net profit, then to carry out the plan of buyback fishing fleets so that it can be reached the established goal in this buyback project effectively. According to the data, it shows that the fisheries resources of offshore and coastal fisheries are decreasing much less, so Fisheries Administration decided to take effect on buyback aged vessels continuously in following years, and increasing the price of buyback vessels up to 40% - 270%. Moreover, the expense of buyback trawl equipment this year will be additionally subsidized. In this case, it will show that the waiting value has been increased tremendously under net profit uncertainty, so that the government will have to increase the payback price to make ship owners have the lure motive to give up their aged vessels.

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