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ANALYSIS ON VESSEL REGISTRATION AND OPERATIONAL PERFORMANCE OF BULK-SHIPPING FIRMS

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Abstract: It has become one important strategy for shipowners to improve their competitiveness by shifting their vessels registration to the countries with more comparative advantages, especially to the Flag of Convenience (FOC). Although the phenomena and causes of vessel flagging out have been discussed in literatures, differentiation on the characteristics of liner and bulk shipping markets with systematic and quantified analysis has not been found. In order to quantify the influence of related factors to the vessel registrations of Taiwan's bulk shipping firms, this study develops a hierarchical analysis framework that consists of four different aspects of objectives being applied by AHP method. Operational performances of five selected public bulk-shipping firms are then analyzed using Data Envelopment Analysis (DEA) method. Inputs and outputs are selected based on the concepts of production function, and the window analysis method is adopted to overcome the limitation of small sample sizes. Finally, the relationships of vessel registration and operational performance of these firms are further explored.

Key Words: bulk carrier, vessel registration, performance evaluation, Analytic Hierarchy Process, Data Envelopment Analysis

1. INTRODCUTION

While the deadweight tonnage (DWT) of global ship fleet is increasing, the DWT of the national vessels of traditional shipping countries is decreasing. The FOC (flag of convenience) vessels have continuously grown to replace national vessels in many traditional shipping countries. The UNCTAD (2003-1998) data shows that although the number and DWT of vessels in Taiwan have increased during 1998 to 2003, the ratio of FOC vessels of which is also increased from 51.71%

to 71.72%. Meanwhile the record of UNCTAD also shows that 40.57% of the global FOC vessels are bulk carriers, which is the highest ratio in the shipping industry. According to statistics of the Ministry of Transportation and Communication, in Taiwan, national vessel has drastically dropped from 4,999,551 DWT in 1993 to 3,065,694 DWT in 2003, which reveals the tendency that vessels in Taiwan are flagging out, especially for bulk carriers. Why do national vessels flag out so drastically, especially in the developed shipping countries? What makes the vessel flag out? What are the differences between being a national vessel and FOC vessel? Attention is worth paying to those basic and other relevant issues.

Shipping companies in different sub-markets exhibit different flagging out behavior (Veenstra and Bergantino, 2000). In view of lacking a systematic and quantified analysis on the influence factors of vessel flagging out, nor about differentiation of liner and bulk shipping markets in the past studies, this paper selects bulk shipping, the most serious flag out vessel as scope of study. The Analytic Hierarchy Process (AHP) method is employed to quantify the relative importance of each influence factor. Furthermore, DEA and Window Analysis method are then used to evaluate the operational performance of 5 major bulk-shipping firms, based on the data collected from those firms. The relationships between vessel registration and operational performance are also discussed lastly. It is anticipated that the findings of this study can provide useful information for concerned parties and government agencies in making relevant decisions.

2. LITERATURE REVIEW

2.1 Vessel Registration

(1) Government Policies: After World War II, in order to avoid government regulations and supervisions, to reduce operational costs, or to be released from constraints of certain markets, shipowners started to shift their vessels registration to the countries with more comparative advantages (Lee, 1996). But shipping policy in most countries usually inclines to protect their own nation fleet by providing financial and/or other kinds of subsidy. Veenstra and Bergantino (2000) indicated that shipping service is a combination of high professional activities, and vessel flagging out is a process leading to different degrees of foreignness in a shipping operation. By flagging out, shipowners progressively increase their foreign element to improve their competitiveness. The first stage of the process is the changes in flag nationality; stage 2 the ship management is transferred abroad; and then the company office in stage 3. To improve competitiveness, Lee (1996) suggested that shipowners should let vessel flagging-out, or

flagging-in in second register, and flagging options should be regarded as critical issue in operating policy.

(2) Operating Costs: Veenstra and Bergantino (2000) mentioned that the savings in operating costs are the most important factor driving shipping companies to change flag, and the savings in traditional shipping countries are higher than in developing countries. Alderton and Winchester (2002) pointed out that crew costs are the most important one among all components of operating costs, and that economical considerations are much more important than political and military reasons nowadays. Bergantino and Marlow (1998) assessed the contribution of various factors on flag-choice and concluded as crew costs 26%, government control 17%, availability of labor 13%, and compliance costs 12%. According to the analysis of Rowlinson and Leek (1997), by employing Asian crews instead of domestic crews, about 56% of crew costs could be saved for a British vessel. Goulielmos (1998) suggested that taxation from shipping should not be the objective of a nation. Knudsen (1997) also pointed out that zero taxation is a common rule in the international shipping industry. Taxation on vessels usually reduces competitiveness of the shipowners.

(3) Operational Conditions: ITF (International Transport Worker Federation) indicated that FOC system could enable shipowners to escape from the burdens of national taxation and national labor protection legislation and seaman union. Cockcroft (1997) suggested vessel operators are not supposed to enjoy government protections and subsidies at the same time. As far as Taiwan shipping industry is concerned, the major factors cause vessel flagging out are insufficient local crews, requirement of dual class, insufficient incentives, trading limits of ROC vessel, and privatization (Lin *et al*. 2001a). Regarding to the demand and supply of manpower, Lin *et al.* (2001b), Lin and Wang (2000) found that under-supply of crew resources in Taiwan has occurred for many years.

(4) Market Environments: Charlton and Gibb (1998) thought that in the process of deregulation and privatization, transportation systems may face stronger environmental, safety and social interventions with higher degree of liberalization. Based on this, vessel flagging out could be regarded as an attempt to self-deregulate of the shipping industry. Bergantino and O'Sullivan (1999) also agreed that the main objective of flagging out is to achieve liberalization of maritime activities. In short, the trend of vessel flagging out is the result of international maritime liberalization.

2.2 Performance Evaluation of Shipping Industry

(1) Evaluation Method: Regarding the evaluation of operational performance in the shipping industry, many studies adopt Factor analysis (Lin, 1992), Correlation analysis (Chou, 1995), or Grey relation (Wang and Feng, 2000) as evaluation method, and focus on liner shipping or entire shipping industry as its scope of study. These previous studies neither consider the differences of two kinds of shipping firms nor explore the relationships between inputs and outputs. Hence, DEA method is selected in this paper, which has been widely applied in many fields, including liner shipping, seaport, air transport, highway transport, railway and public transport.

(2) Inputs/Outputs Selection: Human resource and financial capability are the most critical elements in the operation of bulk shipping since it is a highly international, competitive, professional and capital-intensive industry. Usually its service capability is measured in terms of number or deadweight tonnage (DWT) of vessels (Tenold, 2003). Based on the concept of production function, "total employee", "total capital" and "bulk carrier" are selected as our inputs. It is pointed out that the market risk is the most critical part in the shipping industry and the major reason is due to the revenue uncertainty. The variation of freight rates and charter hires is essentially random and unpredictable (Veenstra and Fransea, 1997). Besides, there is no significant difference between the freight rates and charter hires of new and old vessels (Tamvakis and Thanopoulou, 2000). Thus, "shipping revenue" is chosen as output of this study. To put it in a nutshell, "total employee", "total capital" and "bulk carrier" are selected as inputs and "shipping revenue" as output of this study. Furthermore, the "total employee" is divided into "off-shore" and "on-board" personnel; the "bulk carrier" is further categorized into "number of ROC vessel", "number of FOC vessel" and "DWT of ROC vessel", "DWT of FOC vessel". And, the output "shipping revenue" is also divided into revenue from "ROC vessel" and "FOC vessel" as well.

3. ANALYSIS ON INFLUENCE FACTORS OF VESSEL REGISTRATION

3.1 Hierarchical Framework and Questionnaire Survey

(1) AHP Evaluation Framework: An essential part of applying AHP method is to develop a specific hierarchical framework for the problem, and then to collect experts' opinions to measure the relative importance of each evaluation criteria. After reviewing relevant literatures and discussing with some selected shipowners, an evaluation framework is developed as shown in

Figure 1.

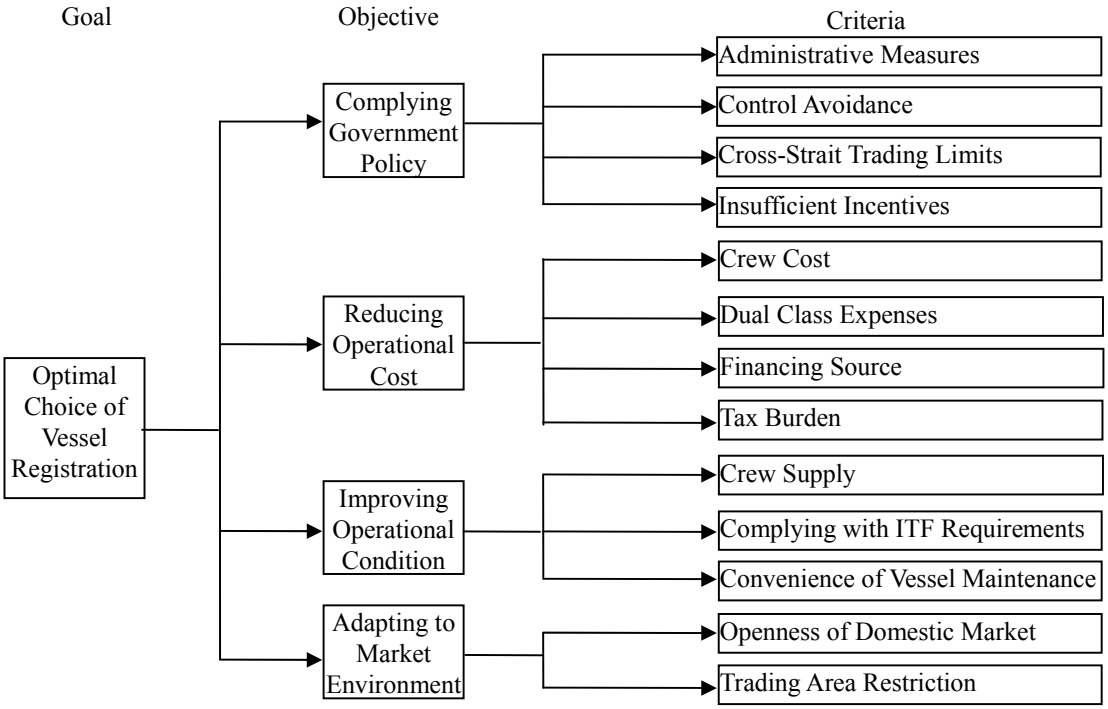

Figure 1. Evaluation Framework of Vessel Registration of Bulk-Shipping

(2) Questionnaire Design and Survey: A questionnaire survey form is then designed following the principles of AHP method, and the survey is conducted by sending out 30 copies of questionnaires to the high rank managerial persons of various domestic dry bulk cargo shipping firms. Only 22 copies of the returned 30 questionnaires are checked as valid, and are used in the following analysis. Table 1 summaries the attributes of these surveyed firms.

Table 1. Summary Attributes of Surveyed Firms

Attributes of Surveyed Firms	Surveyed Copies	Returned Copies	Valid Copies	% of Valid Copies
Nationality Registry				
FOC Only	29	10	8	73.33%
ROC and FOC		15	13	
Subtotal		25	21	
Scale of Tonnage				
Small Scale	29	14	12	
Large Scale		11	9	
Subtotal		25	21	
Listed or Not				
Listed Firms	29	6	6	
Not Listed Firms		19	15	
Subtotal		25	21	
Union	1	1	1	
Total	30	26	22	

3.2 Weights of Evaluation Objective and Criteria

(1) Weights of Evaluation Objective: Table 2 summarized the resultant weights of each objective derived from the valid questionnaires, using APH method. It reveals that reducing operational cost is the most important factor among all factors that influence registration decision making, followed by adapting to market environments and improving operational conditions.

Table 2. Weights of Evaluation Objectives

Objective	Overall Result	Group Results (weights)					
		Vessel Registration		Scale of tonnage		Listed or not	
	Weight	FOC	ROC/FOC	Small	Large	Listed	Not Listed
(A) Complying government policy	0.167 **(4)**	0.138 **(4)**	0.179 **(4)**	0.157 **(4)**	0.167 **(4)**	0.170 **(4)**	0.159 **(4)**
(B) Reducing operational cost	0.335 **(1)**	0.335 **(1)**	0.333 **(1)**	0.350 **(1)**	0.326 **(1)**	0.333 **(1)**	0.334 **(1)**
(C) Improving operational condition	0.239 **(3)**	0.257 **(3)**	0.236 **(3)**	0.254 **(2)**	0.230 **(3)**	0.229 **(3)**	0.250 **(3)**
(D) Adapting to market environment	0.260 **(2)**	0.270 **(2)**	0.253 **(2)**	0.239 **(3)**	0.276 **(2)**	0.268 **(2)**	0.256 **(2)**

Note: ( ) represents the order of importance.

(2) Weights of Evaluation Criteria: The results are summarized in Table 3. The total weight of the first 5 criteria is about 56%, and the total weight of the first 10 criteria is as high as 90%. No matter overall evaluation or group evaluation, “trading area restriction” is the most important key factor among all criteria. As the result of opening up in domestic market and privatization of government-owned business, ROC vessels gradually lost their competitiveness. In this analysis, “crew cost” is considered as the second key factor by most groups except for those firms with public stock. The crew shortage and high cost make it difficult for ROC vessel owner to follow the must of hiring domestic crews.

As far as overall evaluation result is concerned, ever since Taiwan became a member in WTO, domestic import market gradually open up which makes ROC vessel lose their vantage at the same time. To make things worse, ROC vessel remains as major transportation mode for national defense purpose, which raises the difficulty to solicit international bank’s financial support and/or required to pay extra interest. Hence, for the group of public-stock firms, tax burden is considered as important as the trading area restriction. Because the Classification Society in Taiwan is not a member of International Associations of Classification Society, IACS, a ROC vessel will have to pay dual class expenses. Furthermore, under the restriction of “Cross-Strait trading limits”, ROC vessels are not allowed to berth at China directly. And according to the stipulation in the “Management of Offshore Shipping Center”, utilization of FOC vessel is implicitly encouraged.

Table 3. Weights of Evaluation Criteria

Criteria	Overall Result	Group Results					
		Vessel registration		Scale of tonnage		Listed or not	
	Weight	FOC	ROC/FOC	Small	Large	Listed	Not listed
(A1) Administration measurement	0.032231 (12)	0.033120 (11)	0.030251 (12)	0.034697 (11)	0.027388 (12)	0.022950 (12)	0.035616 (12)
(A2) Avoiding control	0.028724 (13)	0.030084 (12)	0.025955 (13)	0.031086 (13)	0.023213 (13)	0.019890 (13)	0.031323 (13)
(A3) Cross-Strait trading limits	0.063961 (10)	0.049680 (9)	0.068557 (7)	0.057933 (10)	0.063961 (8)	0.071740 (7)	0.056604 (10)
(A4) Insufficient incentive	0.042251 (11)	0.025116 (13)	0.054237 (11)	0.033127 (12)	0.052438 (10)	0.055420 (10)	0.035616 (11)
(B1) Crew cost	0.113900 **(2)***	0.115575 **(2)**	0.109557 **(2)**	0.111650 **(2)**	0.118338 **(2)**	0.088911 **(5)**	0.122244 **(2)**
(B2) Dual class expenses	0.065325 (9)	0.080735 (8)	0.054945 (10)	0.080850 (8)	0.048900 (11)	0.047952 (11)	0.071142 (8)
(B3) Finance plan	0.082075 **(5)**	0.093800 **(4)**	0.074925 (6)	0.094850 **(3)**	0.070742 (6)	0.078588 (6)	0.082832 (6)
(B4) Tax burden	0.074035 (6)	0.045225 (10)	0.093573 **(4)**	0.063000 (9)	0.088346 **(5)**	0.117549 **(2)**	0.057782 (9)
(C1) Crew supply	0.096078 **(3)**	0.083525 (6)	0.101244 **(3)**	0.088138 **(5)**	0.102350 **(3)**	0.099615 **(3)**	0.092250 **(4)**
(C2) Complying with ITF requirement	0.073851 (7)	0.092263 **(5)**	0.067732 (8)	0.083058 (6)	0.067620 (7)	0.058624 (9)	0.084750 **(5)**
(C3) Vessel maintenance	0.068832 (8)	0.081212 (7)	0.067024 (9)	0.082804 (7)	0.060030 (9)	0.070761 (8)	0.073000 (7)
(D1) Openness of domestic market	0.095940 **(4)**	0.105840 **(3)**	0.092092 **(5)**	0.091059 **(4)**	0.101016 **(4)**	0.090316 **(4)**	0.099840 **(3)**
(D2) Trading area restriction	0.164060 **(1)**	0.164160 **(1)**	0.160908 **(1)**	0.147941 **(1)**	0.174984 **(1)**	0.177684 **(1)**	0.156160 **(1)**

Note: ( ) represents to the order of weights.

4. EVALUATION OF OPERATIONAL PERFORMANCE

4.1 Data Envelopment Analysis

The concept of DEA is to map all inputs and outputs of decision making units, DMU, on a designated space so as to seek the margin of the lowest input or the highest output (Thannassoulis, 2000); then each DMU lays on this margin will be defined as the effective unit. The DMU score is the ratio of sum of weighted input and sum of weighted output, and it is a comparative value but not an absolute one. Based on rule of thumb, the no. of DMU should be greater than double of the sum of inputs and outputs. In order to overcome the constraint of limited DMUs in this study, the Window Analysis Method proposed by Charnes *et al.* (1985) is adopted. Inputs and outputs data of the five major bulk shipping firms over the past 6 years (1996-2000) are collected, from which 50 DMUs are sorted out by taking every consecutive 2 years as a window.

4.2 Inputs/Outputs Data

Considering the effect of inflation, the original inputs and outputs data from 1996~2001 are firstly adjusted on the basis of 2001 consumer price index (CPI), as listed in Table 4. These 8 inputs and 2 outputs in Table 4 are selected based on literatures review and interviews with experts in bulk shipping firms. But a correlation analysis indicates that many of the inputs are

closely correlated, and after performing statistical tests, only 2 inputs; namely the DWT of ROC vessels and DWT of FOC vessels, together with the 2 inputs are used by DEA models for performance evaluation.

Table 4. Inputs and Outputs Data

DMUs	Year	Inputs																Outputs			
		# of employee				Total assets				Bulk carriers								Shipping revenues			
		Off-shore	%	On-board	%	Domestic (Thousand)	%	Foreign (Thousand)	%	# of ROC	%	# of FOC	%	DWT of ROC ship	%	DWT of FOC ship	%	ROC Income	%	FOC Income	%
M	2001	57	10	486	90	14,026,115	76	4,527,000	24	19	70	8	30	1,483,538	64	833,228	36	3,090,832	56	2,394,973	44
	2000	60	10	548	90	18,693,190	84	3,447,742	16	19	70	8	30	1,483,538	64	833,228	36	3,823,410	67	1,844,957	33
	1999	61	10	545	90	16,821,255	87	2,546,882	13	20	77	6	23	1,634,036	71	672,783	29	2,787,640	72	1,058,816	28
	1998	59	10	522	90	16,022,052	85	2,852,465	15	18	72	7	28	1,473,035	67	709,320	33	2,963,342	71	1,238,592	29
	1997	59	11	477	89	15,668,153	83	3,244,342	17	17	71	7	29	1,453,384	67	709,320	33	2,960,641	67	1,450,255	33
	1996	55	10	474	90	14,901,029	93	1,202,062	7	17	74	6	26	1,448,586	78	413,985	22	3,437,986	80	850,622	20
	Ave.	59	10	509	90	16,021,966	85	2,970,082	15	18	72	7	28	1,496,020	69	695,311	31	3,177,308	69	1,473,036	31
N	2001	30	11	250	89	6,758,743	54	5,712,531	46	3	25	9	75	156,159	11	1,213,850	89	676,462	30	1,546,242	70
	2000	32	11	272	89	7,471,209	59	5,185,464	41	5	38	8	62	454,938	30	1,064,454	70	934,232	38	1,508,528	62
	1999	33	11	271	89	6,865,758	58	4,920,103	42	4	31	9	69	441,348	26	1,230,456	74	975,468	46	1,138,283	54
	1998	33	11	275	89	7,546,790	64	4,317,326	36	5	38	8	62	590,855	39	908,933	61	1,010,370	45	1,230,174	55
	1997	32	11	271	89	8,547,457	64	4,775,248	36	5	38	8	62	590,855	38	945,914	62	1,493,283	60	977,352	40
	1996	32	9	316	91	9,981,068	79	2,594,970	21	7	47	8	53	922,313	54	800,468	46	1,578,978	76	512,145	24
	Ave.	32	10	276	90	7,861,838	63	4,584,274	37	5	36	8	64	526,061	33	1,027,346	67	1,111,465	49	1,152,121	51
S	2001	37	11	315	89	3,424,995	69	1,534,656	31	1	7	14	93	66,735	8	737,960	92	199,719	11	1,678,730	89
	2000	39	10	360	90	5,837,563	75	1,951,830	25	1	6	15	94	66,735	8	764,930	92	263,659	14	1,628,191	86
	1999	50	12	351	88	5,485,599	58	3,999,188	42	1	6	16	94	66,735	8	773,525	92	286,209	15	1,678,145	85
	1998	40	9	408	91	6,627,956	67	3,265,900	33	2	11	16	89	129,078	15	753,393	85	370,706	21	1,420,584	79
	1997	40	12	292	88	6,612,513	74	2,266,179	26	2	14	12	86	129,078	20	517,082	80	366,608	26	1,056,126	74
	1996	38	13	250	87	4,267,641	70	1,822,329	30	2	17	10	83	129,078	23	435,970	77	430,049	25	1,277,851	75
	Ave.	41	11	329	89	5,376,044	69	2,473,347	31	2	10	14	90	97,907	14	663,810	86	319,492	18	1,456,605	82
E	2001	23	8	249	92	1,367,132	62	847,681	38	3	25	9	75	205,486	24	664,364	76	502,687	23	1,673,637	77
	2000	23	10	207	90	1,522,695	24	4,877,715	76	3	30	7	70	205,486	29	514,164	71	558,239	28	1,468,349	72
	1999	24	10	206	90	1,625,209	21	6,037,761	79	3	27	8	73	205,486	26	584,958	74	429,145	27	1,161,347	73
	1998	24	15	140	85	1,741,098	18	7,961,986	82	3	43	4	57	205,486	41	290,457	59	466,907	24	1,475,360	76
	1997	25	17	119	83	1,852,636	51	1,778,643	49	3	60	2	40	205,486	59	144,366	41	491,268	26	1,417,328	74
	1996	25	18	114	82	2,679,536	63	1,556,832	37	4	67	2	33	273,823	65	144,366	35	629,475	33	1,268,449	67
	Ave.	24	10	173	90	1,798,051	40	3,843,436	60	3	42	5	58	216,876	41	390,446	59	512,954	27	1,410,745	73
L	2001	29	14	180	86	1,287,370	29	3,202,952	71	1	11	8	89	37,389	8	417,384	92	240,016	24	755,899	76
	2000	29	19	120	81	1,287,246	48	1,415,013	52	1	17	5	83	37,389	16	197,935	84	243,266	37	417,871	63
	1999	28	21	104	79	2,421,362	100	0	0	5	100	0	0	162,267	10	0	0	602,517	10	0	0
	1998	26	20	101	80	2,391,671	100	0	0	5	100	0	0	162,267	10	0	0	623,603	10	0	0
	1997	29	22	105	78	2,842,583	100	0	0	5	100	0	0	162,267	10	0	0	746,137	10	0	0
	1996	28	21	103	79	2,515,521	100	0	0	5	100	0	0	162,267	10	0	0	891,436	10	0	0
	Ave.	28	20	119	80	2,124,292	79	769,661	21	4	71	2	29	120,641	71	102,553	29	557,829	77	195,628	23

4.3 Results of DEA models

(1) CCR Window Analysis: According to the rule of thumb, at least 8 DMUs are required ((2+2) x 2=8). To comply with this requirement, we denote a window for every 2-year, with total 5 windows for analysis, as shown in Table 5. Every same window of each DMU can be considered as an effective set for relative effectiveness evaluation. In the study of performance of distribution center, Ross and Droge (2002) also applied the Window Analysis with 4-year data to measure the performance. The theory of Window Analysis is to examine the stability of each DMU in different windows. Charnes *et al*. (1985) proposed that operation can be defined as not stable when the variation of effectiveness value is over 0.05.

Table 5. Windows of Analysis

Window 1	1996	1997				
Window 2		1997	1998			
Window 3			1998	1999		
Window 4				1999	2000	
Window 5					2000	2001

Table 6 is the result of overlapping CCR Window Analysis. It shows that firm N is under unstable condition for all 5 periods, where as firm L and M each are unstable only in 2 of the 5 periods, which could be considered as having relative good performance, followed by firm S.

Table 7 is the result of CCR Window Analysis. The mean value represents the relative effectiveness of each year from 1996 to 2001. The average effectiveness of firm L is also shown as the highest one, followed by firm S and E. The variance on the other hand explains the variation degree of each year's effectiveness, and the result shows that firm M and E have the highest value, followed by firm S and firm L with the lowest variation. The mean value and variance can be combined together as the coefficient of variation. According to that coefficient in Table 7, it may be concluded that firm L performs the best, followed by firm S and E.

Table 6. Overlap Window Analysis with CCR Models

DMUs / Years		1996	1997	1998	1999	2000	2001
M	Window 1	0.47	0.43				
	Window 2		0.50	0.48			
	Window 3			0.55	0.47		
	Window 4				0.55	0.78	
	Window 5					1	1
	Column Range	0	0.07	0.07	0.08	0.22	0
	Max. Range	0.57					
N	Window 1	0.33	0.53				
	Window 2		0.61	0.47			
	Window 3			0.49	0.56		
	Window 4				0.43	0.56	
	Window 5					0.59	0.67
	Column Range	0	0.08	0.02	0.13	0.03	0
	Max. Range	0.34					
S	Window 1	1	0.84				
	Window 2		0.94	1			
	Window 3			0.80	1		
	Window 4				1	0.98	
	Window 5					1	1
	Column Range	0	0.10	0.20	0	0.02	0
	Max. Range	0.20					
E	Window 1	0.89	1				
	Window 2		1	0.96			
	Window 3			1	0.68		
	Window 4				0.73	1	
	Window 5					1	0.94
	Column Range	0	0	0.04	0.05	0	0
	Max. Range	0.32					
L	Window 1	1	0.84				
	Window 2		1	0.84			
	Window 3			1	0.97		
	Window 4				1	1	
	Window 5					1	1
	Column Range	0	0.16	0.16	0.03	0	0
	Max. Range	0.16					

Table 7. Cross Window Analysis with CCR Models

Years \ DMUs	M	N	S	E	L
1996	0.47	0.33	1	0.89	1
1997	0.43	0.53	0.84	1	0.84
1997	0.50	0.61	0.94	1	1
1998	0.48	0.47	1	0.96	0.84
1998	0.55	0.49	0.80	1	1
1999	0.47	0.56	1	0.68	0.97
1999	0.55	0.43	1	0.73	1
2000	0.78	0.56	0.98	1	1
2000	1	0.59	1	1	1
2001	1	0.67	1	0.94	1
Mean	0.623	0.524	0.956	0.920	0.965
Variance	0.220910	0.097889	0.074714	0.119536	0.066542
Max. Range	0.57	0.34	0.20	0.32	0.16
Max. Column Range	0.22	0.13	0.20	0.05	0.16
Coefficient of Variation	0.354590	0.186811	0.078153	0.129931	0.068955

(2) BCC Window Analysis: Similar analyses are also conducted by using BCC models and the results are summarized as in Table 8 and Table 9. Table 8 is the result of overlapping BCC Window Analysis. It shows that firm N is under unstable condition for 4 periods, whereas firm L is stable in all of the 5 periods, which could be considered as having the best performance, followed by firm M and S.

Table 8. Overlap Window Analysis with BCC Models

DMUs / Years		1996	1997	1998	1999	2000	2001
M	Window 1	1	1				
	Window 2		1	1			
	Window 3			1	0.98		
	Window 4				0.84	1	
	Window 5					1	1
	Column Range	0	0	0	0.14	0	0
	Max. Range	0.16					
N	Window 1	0.60	0.97				
	Window 2		1	0.70			
	Window 3			0.73	0.92		
	Window 4				0.75	0.71	
	Window 5					0.71	1
	Column Range	0	0.03	0.03	0.17	0	0
	Max. Range	0.40					
S	Window 1	1	1				
	Window 2		1	1			
	Window 3			0.81	1		
	Window 4				1	0.98	
	Window 5					1	1
	Column Range	0	0	0.19	0	0.02	0
	Max. Range	0.19					
E	Window 1	0.97	1				
	Window 2		1	1			
	Window 3			1	0.68		
	Window 4				0.73	1	
	Window 5					1	1
	Column Range	0	0	0	0.05	0	0
	Max. Range	0.32					
L	Window 1	1	1				
	Window 2		1	1			
	Window 3			1	1		
	Window 4				1	1	
	Window 5					1	1
	Column Range	0	0	0	0	0	0
	Max. Range	0					

Table 9 is the result of BCC Window Analysis. The mean value represents the relative effectiveness of each year from 1996 to 2001. The average effectiveness of firm L is also shown as the highest one, followed by firm M and S. Firm N and E have the highest value of variance, followed by firm M and firm L. The mean value and variance are also combined together as the coefficient of variation. According to that coefficient in Table 9, it may be concluded that firm L performs the best, followed by firm M and S.

Table 9. Cross Window Analysis with BCC Models

DMUs / Years	M	N	S	E	L
1996	1	0.60	1	0.97	1
1997	1	0.97	1	1	1
1997	1	1	1	1	1
1998	1	0.70	1	1	1
1998	1	0.73	0.81	1	1
1999	0.98	0.92	1	0.68	1
1999	0.84	0.75	1	0.73	1
2000	1	0.71	0.98	1	1
2000	1	0.71	1	1	1
2001	1	1	1	1	1
Mean	0.982	0.809	0.979	0.938	1
Variance	0.050288	0.147607	0.059712	0.123720	0
Max. Range	0.16	0.40	0.19	0.32	0
Max. Column Range	0.14	0.17	0.19	0.05	0
Coefficient of Variation	0.051210	0.182456	0.060993	0.131898	0

The result of BCC Window Analysis indicates that firm N is most unstable, where as firm L is most stable. The stability of firm L once again is better than all other shipping firms. The result is basically consistent with CCR analysis.

4.4 Discussion

After discussing with shipping experts, it is found out that shipowners are more willing to register their old vessels as FOC and remain new vessels as ROC. The vessel registration also depends on business type of the bulk-shipping firms. If the operation runs on voyage charter (collect ocean freight) basis, vessel registering in ROC is higher than registering in FOC, but if the operation runs on time charter (collect charter hire) basis, vessel registering in FOC is higher than registering in ROC.

Table 10 shows that all the five bulk-shipping firms are inclined to increase the proportion of FOC vessel. In comparison with the statistical data of UNCTAD, except firm M, the ratio of FOC registry is far higher than UNCTAD records, which means that flagging out of bulk shipping in Taiwan is getting serious in recent years.

Table 10. Vessel Registrations of Major Bulk Shipping Firms (unit: %)

DMUs / Years	M		N		S		E		L	
	ROC	FOC	ROC	FOC	ROC	FOC	ROC	FOC	ROC	FOC
1996	78	22	54	46	23	77	65	35	100	0
1997	67	33	38	62	20	80	59	41	100	0
1998	67	33	39	61	15	85	41	59	100	0
1999	71	29	26	74	8	92	26	74	100	0
2000	64	36	30	70	8	92	29	71	16	84
2001	64	36	11	89	8	92	24	76	8	92

Source：Huang and Chung, 2005.

5. CONCLUDING REMARKS

(1) This study develops a hierarchical evaluation framework consists of four different aspects of objectives, including policy, cost, operation and market, to analyze degree of influence of related factors on vessel registration of Taiwan bulk-shipping firms. Among all, “reducing operational cost” is the most important objective whose weighted value is 33.5%, followed by “adapting to market environment” as 26.0%, “improving operational condition” as 23.9% and “complying with government policy” as 16.7%. As among the 13 evaluation criteria, “trading area restriction” is the most important key influence factor with weight 16.41%, followed by “crew cost” as 11.39%, “crew supply” as 9.61%, “openness of domestic market” as 9.59%, “finance plan” as 8.21% and “tax burden” as 7.40%. In other words, the decision of vessel flagging out is not only influenced by economics reasons but also by political factors.

(2) Evaluation of operational performance, by both CCR and BCC models reveal that firm L has the best stability and performance, followed by firm M and S. This result is actually related to the business type. The main business of firm L and S are “time charter” but supplemented by “voyage charter”, which means they have regular and stable charter hire revenues. Firm M controls the contract of affreightment (COA) of associated business also help to reduce the impact of market price variation. Besides, the supply-demand of vessel tonnage has direct impact on shipping revenues. The market situation during the study period is under the circumstances of supply excess the demand, and since the abovementioned 3 firms in the study period take proper action to operate as “time charter” and sign COA for cargo carrying to stabilize their revenue, of which the stability and performance are thus relatively better.

(3) CCR Window Analysis shows that firm L has the best operational performance, followed by firm S and E, whereas BCC analysis shows firm L is the best, but followed by firm M and S. The reason that firm M performs worst in CCR model than in BCC model is mainly due to a decrease of scale revenue in firm M. This reminds us that it is essential to take the effect of economic scale on bulk shipping operation into considerations.

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