



Original article

Analysis of on-board Job Taking and Separation of Korean Merchant Seafarers[☆]

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Abstract

A stable supply of seafarers is an important issue for Korean maritime industries and related business activities. After four years of their role on a ship, Korean maritime officers are increasingly being separated from their fellow sailors. The present paper reviews the trend and characteristics in the separation rate of maritime officers, and examines the main factors affecting the separation rate through panel data models. The paper collects the panel data of maritime officers from 2007 to 2014. The main results of panel data models show us that the separation rate is affected mainly by the duration (period) after graduation. The unemployment rate in all industries and the relative wage level of seafarers affect negatively the separation rate. The dummy variable for the completion year of military services shows positive coefficients. We can conclude that the labour market of seafarers is affected by the employment situation in all industries.

Keywords: Seafarer, Maritime Officer, Labour Market, Korea, Separation

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1. Introduction

Seafarers play a key role in maritime industries and business activities, providing essential skills and services in merchant shipping, fishing, ship operation and management, safety management of ships and ports, pilotage, tug boat service, maritime distress judgment, marine insurance and dynamic positioning of oil and offshore vessels (Gardner and Pettit, 1999). Their main duties include navigation, engine operations, and fishing on fishing boats.

Seafarers in Korea are educated and trained by maritime academic institutions such as Korea Maritime and Ocean University (KMOU), Mokpo National Maritime University (MMU), Pukyong National University (PNU), Busan National Maritime High School (BNMH), and Korea Institute of Maritime and Fisheries Technology (KIMFT), to name a few. Although a stable supply of sailors is an important issue to the ocean industries and related businesses, the number of Korean seafarers on-board has shown a continual decrease since the 1990s. The total number of Korean seafarers on ships reduced from 105,667 in 1990 to 36,976 in 2015. In detail, merchant shipping seafarers increased slightly from 15,952 to 17,552, whereas fishing seafarers excluding seafarers employed overseas reduced from 53,272 to 16,820 during the same period (Korea Seafarer's Welfare and Employment Center, 2016).

As of 2015, the rate of the first year job taking stands at 84.3% including the reserves, equating to 892 out of 1,058 graduates in 2015 (Korea Seafarer's Welfare and Employment Center, 2016). At the same time, the rate of separation stands at 15.7%, equating to 166 separators. The rate of job taking decreases quickly after they pass the fourth year, which is the finishing year of military service. If we look at 2011 as an example, the rate of job taking in the fourth year of graduates stands at 76.3%, and decreases to 59.9% in the fifth year, 43.1% in the sixth year, and as low as to 37.5% in the seventh year.

The purpose of the present paper is to review the peculiarities of the seafarer market in Korea and to examine the main factors and their effects in the market. In order to test the factors and their effects in the market, the present paper collects panel data of Korean seafarers and explores the interaction the main factors and the seafarer market through panel data models. The paper is

structured in the following: Section 2 includes a literature review on the world seafarer market and describes the methodology of the paper. Section 3 discusses supply and separation of Korean maritime officers. Section 4 focuses on panel data of maritime officers and analyses the separation rate of maritime officers through panel data models. Section 5 concludes the paper and suggests policy implications.

2. Literature Review and Methodology

2.1. Literature Review

When working on-board, seafarers need to be qualified in accordance with ship types and must possess the necessary skill qualifications, for the working department on a ship (Glen, 2008). The working qualification of seafarers is guaranteed by an international agreement such as the Standards of Training, Certification and Watchkeeping (STCW) convention. Since maritime industries are globalized and supply global shipping networks, the seafarer market is also exposed to global trends and competition. We can see examples of global trends in the supply of seafarers through multiculturalism, multi-nationality and a deficiency of seafarers from developed countries (Wu and Winchester, 2005; Silos et al., 2012). According to BIIMCO/ISF (2016), the world supply of maritime officers was deficient in 2015: the number of supply being 774 thousand officers and a demand of 790.5 thousand officers. Ng and Yip (2006) point to another issue of lower attractiveness of a seafaring life to the young generation and a high separation rate of seafarer's in Hong Kong.

When analyzing the supply and demand of seafarers in a labour market study, we can find some common and also peculiar characteristics. The market of seafarers is balanced by countervailing interaction between supply and demand. The flow of supply is composed of stayers, entrants, separation, and/or wastage of supply (Fredericksen and Westergaard-Nielson, 2007; Glen, 2008, 846). Furthermore, we can differentiate two different concepts of seafarer supply: active seafarers and qualified seafarers (Li and Wonham, 1999; Glen, 2008, 846).

Skilled and experienced seafarers also face selection decision of on-board job taking, seeking jobs and separation. Most of the literature on the retirement age of seafarers are assuming the age to be around 57~62 (Glen,

2007).

While discussing the long-term shortage of seafarer supply in the world, Leggate reviews supply and demand of seafarers, and highlights the main sources of demand (Leggate, 2004). The demand growth in seafarer market comes from the development of a world merchant fleet. Different types and sizes of ships require a variety of compositions of manning seafarers (BIMCO, 2015). Since shipping companies try to reduce operation costs by an incessant enlargement of ship size, demand of seafarers tends to grow less than proportional increase with the enlargement of ship size.

In Korea, we can also find similar issues in the seafarer market: deficient supply, imbalance between supply and demand, and increasing foreign seafarers under the Korean flag (Korea Maritime Institute, 2000; Jeong, 2004; Jeon, 2013; Park, 2016b; Wang et al., 2016). However, Korean seafarers have their own peculiarities. First, Korean male cadets are willing to be exempted from the military service, which is compulsory for the male youth in Korea by taking an on-board job for four to five years. Hence, the proportion of on-board job taking of entrants who graduated educational institutions tends to fall down widely around four or five years after entering the market. Second, Korean cadets are educated by the national expenditure in educational and training courses. The education institutions of seafarers in Korea could sustain the number of cadets in a specified level year by year. Third, Korea has a well-organized system for seafarer statistics. Korea annually publishes Seafarer's Statistics and traces the working status of officers from education institutions such as KMOU, MMU, and PNU. The Seafarer's Statistics annually informs us of the numbers of active seafarers and qualified seafarers.

The present paper recognises the peculiarities of the seafarer market in Korea. The seafarer market in Korea shows common characteristics of supply and demand as in the general labour market, such as main effects of wage level and fringe benefits. Therefore, we can interpret the separation from on-board jobs as a labour shift to other jobs seeking better working condition.

2.2. Theoretical Approach

Basically, the microeconomic theory explores the labour market in a tool of selection choice between working and leisure (Varian, 1987, 170-174). While

adopting the budget constraint of each labourer to a seafarer, we can develop a budget constraint of a seafarer:

$$p C = M + w_1 L_1 + w_2 L_2 \quad (1)$$

where,

p: price of consumption,

C: amount of the consumption,

M: non-labour income,

w₁: wage rate of labour supply on-board

w₂: wage rate of labour supply on-shore

L₁: labour supply on-board,

L₂: labour supply at on-shore or other working such as manufacturing.

We can differentiate Equation 1 and arrange it as in the following, if ΔC is 0. We assume that the budget of a seafarer is fixed.

$$\Delta L_1 = - (w_2 \Delta L_2) / w_1 \quad (2)$$

From Equation 2, we find that the increase of labour supply and wage level of on-shore or in other areas of employment will decrease the labour supply on-board. The rise of wage level of labour supply on-board will increase the labour supply on-board. Equation 2 means that if we fix the consumption, the labour supply of seafarers depends on the relative wage of working on board in comparison with the wage on-shore.

2.3. Empirical Model

We explore further peculiarities of the working condition of Korean seafarers. Separation in the labour market can be interpreted in the framework of wage and fringe benefits (Dale-Olsen, 2006). The fringe benefits for a seafarer can be a stable on-board job in contrast to possible unemployment on-shore. Besides wage, the most important fringe benefit of seafaring in Korea is an alternative to military service, which is compulsory to young men in Korea. Korean seafarers, in the case of maritime officers, are exempted from the duty of national defence by taking an on-board job. The present paper uses a simple equation of separation rate of Korean seafarers, adopted from labour supply Equation 1 and 2.

The separation rate of *i* graduate group in *t* year is presented in Equation 3 (Park, 2016a, 160).

$$Sep_{it} = f(Wage_{it}, Un_{it}, Period_{it}) \quad (3)$$

where,

Sep_{it} : separation rate of i graduate group in t year

$Wage_{it}$: wage of i graduate group in t year

Un_{it} : unemployment rate of all industries in t year

$Period_{it}$: years (period) after graduation of i graduate group in t year

In addition, we can modify the wage of i graduate group in t year into a relative wage level as shown in Equation 4.

$$Sep_{it} = f(Rwage_{it}, Un_{it}, Period_{it}) \quad (4)$$

where,

$Rwage_{it}$: relative wage of i graduate group in t year compared to average wage of establishments in manufacturing

The present paper uses mainly a wage level for marine officers when they separate from on-board work: average wage of establishments with 10 and over permanent employees in manufacturing. Hence, the paper calculates the type of relative wage for seafarers as in the following.

$rwageof 1 = (\text{average wage of 3}^{\text{rd}} \text{ officer on Korean flag}) / \text{average wage of establishments with 10 and over permanent employees in manufacturing}$

The officer seafarer market in Korea can be divided mainly into two parts: seafarers on deck and in the engine room. Deck officers work in navigation and, after 15 to 20 years working on-board and 5 years of working as a captain, can apply to be a pilot; merchant engine officers take responsibility in the engine room and can easily move their career as a seafarer into the fishing industry in accordance with Article 4 (Classification and classes of Occupational Licenses) of the Ship Personnel Act of Korea. These different characteristics between deck officers and engine officers can differentiate the trend of on-board job taking and separation year by year. Hence, the present paper analyses first the separation rate in the same graduate group by graduation year, and then divides the same graduate group into two small groups: deck officers and engine officers.

Table 1: Job taking and separation of officers in 2015 of the group graduating in 2015 (unit: person)

Item	Total	(Ratio)	on board	reservation	separation
Total	1058	1.000	603	289	166
Deck officer	472	0.446	292	135	45
KMOU	174	0.164	102	48	24
MMU	190	0.180	122	53	15
Other	108	0.102	68	34	6
Engine officer	457	0.432	282	140	35
KMOU	157	0.148	99	47	11
MMU	184	0.174	110	57	17
Other	116	0.110	73	36	7
Without certificate	129	0.122	29	14	86
KMOU	52	0.049	2	-	50
MMU	28	0.026	5	-	23
Other	49	0.046	22	14	13

Source: Korea Seafarer's Welfare & Employment Center (2016).

3. Supply of Seafarers and Separation in Korea

Korean educational institutes train and educate deck officers and engine officers in merchant shipping. For example, the graduates of 2015 account for 1,058 as shown in Table 1. Among them, 929 were awarded the certificate of seafarer but 129 at a rate of 12.2% of graduates failed or chose other jobs. 929 officers can be divided into groups of department and different educational institutes; 472 deck officers and 457 engine officers; 174 deck officers from KMOU, 190 from MMU, and 108 other institutes such as BNMH; 157 engine officers from KMOU, 184 from MMU, and 116 other institutes such as BNMH.

During the first year after graduation, 37 at a rate of 3.5% of graduates separated from jobs as seafarers. Hence, in the end of their first year as a seafarer, 166 separated. The number of separated seafarer in the end of the first year also includes graduate students without a seafarer certificate. The share of separation from on-board jobs is as follows: deck officers 27.1% of total separation, engine officers at 21.1%, and the graduates without a certificate at 51.8%. When taking a closer look

at the number of graduates without certificate, we find there are 129 graduates: the graduates from KMOU account for 51; MMU 28; and other institutes such as BNMA 49. The highest number without a certificate is from KMOU. The reason seems to be caused by the broader job opportunity for the graduates of KMOU than other institutions.

The high separation rate of Korean seafarers has led to the invitation of foreign seafarers for on-board jobs on Korean-flag vessels since the early 1990s. Nowadays, foreign seafarers numbered 12,136 in 2015 and are the main sources of ratings (Korea Seafarer’s Welfare & Employment Center, 2016).

Although Korean seafarers are trained and educated in educational institutes, they show dynamics in the seafarer labour market. The influx of foreign seafarers to Korean-flagged vessels adds a complication in the supply of seafarers.

4. Panel Data Models and Main Results

4.1. Panel Data

The paper collects data of maritime officers who graduated in 1991, 1996, and 2001, and from 2001 to 2006: eight groups of different graduate years. The total number of maritime officers of the eight groups is 9,564 as presented in Table 2. The paper collects the panel data of the same eight groups from 2007 to 2014.

The paper adds the data on wage and unemployment in manufacturing and other industries from the Ministry of Employment and Labour and the Korea Labour Institute. When a seafarer separates from an on-board job, he tends to get an onshore job in the maritime industries or other industries. Therefore, the paper considers a labour shift from an on-board job to a job onshore and other industries as a labour turnover.

Table 2: Composition of panel of different eight graduate groups

Graduation year	91	96	2001	2002	2003	2004	2005	2006	Total
Numbers	1,962	696	1,094	1,237	1,141	1,107	1,120	1,207	9,564

Table 3: Summary of panel data and variables

Variable	Cases	Average	SD	Minimum	Maximum
total	64	1195.6	331	696	1962
board	64	294.3	203	80	829
brate	64	.25	.17	.07	.69
separation	64	901.3	395	378	1828
seprate	64	.75	.17	.31	.93
owage	64	3295.8	322.0	2673	3709
ffwage	64	6246.6	709.5	4635	6878
umet2529	64	.06	.01	.06	.08
ttlunem	64	.03	.00	.03	.03
avgwage	64	3208.6	321.7	2772	3716
univwage	64	3866.8	248.7	3545	4307

Source: Korea Seafarer’s Welfare & Employment Center, each year. Korea Labour Institute, Labour Statistics, each year.

Note: 1) board: seafarer number of on-board job taking; brate: rate of on-board job taking; separation: seafarer number of separation; seprate: rate of separation; owage: average wage of merchant 3rd officers on Korean flag; ffwage: average wage of Korean seafarers on foreign flag; umet: unemployment rate of the age group from 25 to 29; ttlunem: total unemployment rate; avgwage: average age of all employees in manufacturing industries; univwage: average age of all university graduates. 2) wage level indicates the unit of thousand Korean won.

Table 4: Correlation table between main variables

	period	seprate	umet2529	ttlunem
period	1.00			
seprate	0.78	1.00		
umet2529	0.26	0.19	1.00	
ttlunem	-0.10	-0.09	0.47	1.00

Table 3 presents us a summary of panel data. The data includes 64 cases of the different eight graduate groups in eight years. The number of on-board job taking (board) in groups of maritime officers range from 80 to 829; separation rate from 7% to 69%. Generally, the wage of foreign flag (ffwage) is higher than that of Korean flag (owage).

Table 4 gives us a correlation between the main variables in the panel data. The period after graduation (period) and separation rate (seprate) demonstrate a positive correlation, indicating that separation rate increases in proportion to years after graduation. While

the unemployment rate of the age group from 25 to 29 (umet) illustrates a weak positive relation with separation rate, total unemployment rate (ttlunem) shows a tiny negative relation with separation rate. Nevertheless, separation rate and relative wage of seafarers show a slight positive correlation.

4.2. Panel Data Models

The paper uses the panel data models as in the following simple Equation 5.

$$Sep_{it} = a_1 + a_2 R_{wage_{it}} + a_3 Un_{it} + a_4 Period_{it} + a_5 Dummy + \varepsilon_{it} \quad (5)$$

where,

Dummy: dummy for the completion year of military services

ε_{it} : error term of i graduate group in t year

The panel data models include pooled regression, a fixed effects model, a random effects model and a generalized least squares estimation (Greene, 2012). However, the separation rate in the present year tends to be accumulated from the rate of the previous year. Hence, we may consider a first-order autocorrelation (AR(1)) in the error term as shown in Equation 6.

$$\varepsilon_{it} = \rho\varepsilon_{it-1} + v_{it} \quad (6)$$

Table 5 shows us the results of testing a first-order autocorrelation in error term's from the panel data. Hence, the paper mainly uses a generalized least squares (GLS) estimation. When separating the panel data into two small groups: deck officers and engine officers, we also find the first-order autocorrelation.

In addition, we test a panel unit root through Levin-Lin-Chu unit root test as presented in Table 6, mainly on separation rate. The null hypothesis assuming that panels contain unit root is rejected. Nevertheless, if we divide the panel data into two small groups: deck officers and engine officers, the group of deck officers rejects the null hypothesis but the group of engine officers does not. When testing Fisher-type unit root in the separation rate of engine officers, we find that the null hypothesis supposing that all panels contain unit root is rejected. Therefore, we can assume that at least one panel in data of engine officers is stationary.

Table 5: Test of first-order autocorrelation

Variables	F Value	Probability>F
<i>Sep, Rwage, Un, Period</i>	F(1.7):-230	0.000

Table 6: Panel unit root test on separation rate

Variables/Panel	All groups	Deck officers	Engine officers	Inverse $\chi^2(16)$, p-value
	p-value	p-value	p-value	
<i>Separation rate</i>	0.000	0.000	0.431	0.000

The different results between deck officers and engine officers in panel unit root tests seem to be caused by the characteristics of two small groups. The opportunity of *deck officers* to become a pilot after 15 to 20 years of on-board job and 5 years of working as a captain may improve stationarity of panel data but the steady pattern of *engine officers* between on-board jobs and separation without the opportunity for applying to become a pilot might worsen the stationarity of panel data. From the results of the panel unit root test, we can conclude that panels show stationarity. Hence the present paper uses Equation 5 as a basic format.

Table 7: Panel data models and main results

Item	M11	M12	M13	dependent variable: separation rate		
	Panel GLS (ar1),		Panel GLS (ar1),		Panel GLS hetero	
	Coef.	P> z	Coef.	P> z	Coef.	P> z
Period	0.03	0.00	0.03	0.00	0.01	0.00
ttlunem	-1.4	0.54	-	-	3.7	0.01
umet2529	-	-	-0.80	0.44	-	-
rwageoffl	-0.04	0.75	-0.06	0.64	0.57	0.00
dummy	0.03	0.03	0.03	0.03	0.01	0.26
_cons	0..56	0.00	0..59	0.00	.-	-
χ^2	55		56		57470	
F(Prob>χ^2)	0.000		0.000		0.0000	

Note: Prob means probability.

4.2. Main Results of All Groups

We use three panel data models: Model 11 (M11) of auto-correlation (1) using total unemployment rate (ttlunem); Model 12 (M12) of auto-correlation (1) using unemployment rates in ages from 25 to 29 (umet2529);

and Model 13(M13) of panel heteroscedasticity using total unemployment rate.

The main results of Model 11, 12, and 13 as shown in Table 7, present that separation rate is affected by the duration (period) after graduation. The effects of unemployment rate of industries and relative wage level of seafarers are positive in M 13. The dummy for the completion year of military service shows positive coefficients in M 11 and M 12.

The main results of three panel data models are resulted from the data of deck officers and engine officers. Hence, we analyse further the separation rate by regrouping merchant officers in the panel into deck officers and engine officers.

4.3. Deck Officers vs Engine Officers

By recognizing the difference between deck officers and engine officers, the paper divides the panel data into two respective groups: deck officers and engine officers. Each of the two groups can be grouped further into two different graduates: graduates in 1991, 1996, and 2001 and graduates from 2002 to 2006. The first graduate group worked after completing on-board jobs for the minimum period for military service during the examined period from 2007 to 2014; and the second group had not finished.

Although the present paper does not present the detail results of panel data models, the panel data models on both deck officers and engine officers show that the variable of period is affecting the separation rate positively in all models and the unemployment rate from 25 to 29 has a negative effect when we divide the groups into the first graduate group and the second graduate group (Appendix A and B). The coefficients of the relative wage level of seafarers are negative in the first graduate group of deck officers in Model of M 22 and M 25, and the second group of engine officers in M 36. Hence the skilled seafarers after completion of military services tend to choose the jobs on-board when the wage increases.

5. Conclusions

Korean seafarers have contributed to the continual growth in maritime industries and economy by transporting exports and imports, fishing, manoeuvring vessels, and assisting maritime and related industries.

Although a stable supply of seafarers is important for the ocean industries and related business activities, the number of Korean seafarers on-board has decreased continually since the 1990s. A high separation rate of maritime officers has worsened the deficient supply of Korean seafarers.

In the test of autocorrelation, the paper finds first-order autocorrelation. This means that the separation rate in the present year is affected by the rate of the previous year. In the panel unit root test of separation rate, we find that the separation rate of deck officers is more stationary than that of engine officers. This seems to be caused by the characteristics of two small groups. Also the opportunity of deck officers to become a pilot after 15 to 20 years of on-board job may improve stationarity of panel data.

The main results of panel data models from the eight graduate groups show us that separation rate is affected by the duration (period) after graduation. The effects of unemployment rate of industries and relative wage level of seafarers are positive. The dummy for the completion year of military service shows positive coefficients.

When dividing the panels into deck officers and engine officers, the duration (period) after graduation and the dummy for the completion year of military service present similar results. But, the coefficients of unemployment rate from ages 25 to 29 are negative in the second groups of deck officers and engine officers. Hence, we can conclude that the labour market of seafarers is affected by the employment situation in all industries.

The present paper has the following policy implications. First, the completion year of military service, a fringe benefit as a seafarer, is a key factor to sustain the rate of on-board job taking. It is necessary for maritime industries to sustain an alternative to military service. Second, the separation rate is affected positively by the duration after graduation. The study on wastage rate of qualified seafarers may improve the quality of analysis on the seafarer market in Korea. Third, the supply of Korean seafarers is exposed to other labour markets. Hence, we need to understand that the seafarer market is related to other labour markets.

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Appendix A: Results of panel data models of separation rate of deck officers

Item	M21		M22		M23		M24		M25		M26	
	All deck officers,		1 st graduate group,		2 nd graduate group		All deck officers		1 st graduate group		2 nd graduate group	
	Coef.	P> z	Coef.	P> z	Coef.	P> z	Coef.	P> z	Coef.	P> z	Coef.	P> z
Period	0.03	0.00	0.01	0.01	0.55	0.00	0.03	0.00	0.01	0.00	0.73	0.00
umet2529	-	-	-	-	-	-	-0.77	0.60	-3.12	0.00	-4.44	0.06
ttlunem	-0.88	0.80	-1.29	0.31	-1.26	0.79	-	-	-	-	-	-
rwageof1	0.20	0.22	-0.14	0.03	0.42	0.07	0.18	0.32	-0.29	0.02	0.13	0.67
dummy	-	-	-	-	0.05	0.08	-	-	-	-	0.09	0.01
cons	0.20	0.35	0.90	0.00	-0.19	0.54	0.25	0.27	1.13	0.00	0.24	0.54
case	64		24		40		64		24		40	

Appendix B: Results of panel data models of separation rate of engine officers

Item	M31		M32		M33		M34		M35		M36	
	All engine officers,		1 st graduate group,		2 nd graduate group		All engine officers,		1 st graduate group		2 nd graduate group,	
	Coef.	P> z	Coef.	P> z	Coef.	P> z	Coef.	P> z	Coef.	P> z	Coef.	P> z
Period	0.32	0.00	0.08	0.00	0.06	0.00	0.01	0.00	0.01	0.00	0.10	0.00
umet2529	-	-	-	-	-	-	-1.13	0.04	-1.29	0.02	-7.91	0.00
ttlunem	0.94	0.78	-0.06	0.97	1.21	0.82	-	-	-	-	-	-
rwageof1	0.21	0.20	0.41	0.60	0.35	0.18	0.09	0.28	0.52	0.52	-1.03	0.00
dummy	-	-	-	-	0.03	0.26	-	-	-	-	0.05	0.00
_cons	0.14	0.53	0.69	0.00	-0.20	0.55	0.68	0.00	0.74	0.00	1.54	0.00
Case	64		24		40		54		24		40	