EMPLOYMENT AND MOBILITY CHARACTERISTICS OF AUSTRALIAN MERCHANT NAVY PERSONNEL

H.B. MILLOY
Planning and Technology Branch
Bureau of Transport Economics

E.M. CASLING
Planning and Technology Branch
Bureau of Transport Economics

S.M. SULLIVAN
Planning and Technology Branch
Bureau of Transport Economics

ABSTRACT: *This study was undertaken to assist in the development of manpower policies for the Australian merchant navy. More specifically the objectives were to review the recent recruitment, promotion and wastage characteristics of personnel in the industry, to estimate the numbers of recruits required in future years to sustain industry growth and to assess the mobility of labour within the industry.*

EMPLOYMENT AND MOBILITY CHARACTERISTICS OF AUSTRALIAN MERCHANT NAVY PERSONNEL

INTRODUCTION

Background

In July 1982 the Commonwealth Government announced a number of policy initiatives to encourage the development of an efficient, revitalised Australian shipping industry. These initiatives accorded with the recommendations made by Sir John Crawford in his 'Report on the Revitalisation of Australian Shipping' (Crawford 1982), which addressed a wide range of issues which affected the industry's ability to compete commercially with both land-based domestic transport and international shipowners. One of the more important of these issues, and the one which formed the background to this study, is the establishment of a new manpower policy for better and more flexible training of maritime personnel.

To assist in the development of manpower, and particularly training policies, in September 1982 the Bureau of Transport Economics (BTE) commenced this study of the employment and mobility characteristics of officers and ratings in the Australian merchant navy. The study was designed to provide a clearer understanding of the recruitment, promotion and wastage characteristics of personnel in the industry and so to estimate the number of recruits who would be required to sustain balanced industry growth. No attempt was made in this study to predict future growth patterns in the industry. Rather the approach has been to discuss the manpower implications for a range of growth rates and leave it to the reader to decide which growth rate will be the most likely.

Australia has a relatively small maritime industry. In July 1982 the total Australian trading fleet, that is, all vessels of 150 gross registered tonnes and over in both the coastal and overseas trades numbered 109 and had a deadweight of 3.4 million tonnes (DoT 1983): of these, 94 were registered in Australia. There were 28 vessels trading overseas and 17 of these were Australian-owned. In 1981-82, Australian-registered vessels carried approximately 4 per cent (in revenue tonnes) of Australia's overseas trade. One of the implicit objectives of the Government's revitalisation package is to enable the industry to transport larger fractions of Australia's exports and imports and hence to increase career opportunities for Australian seamen.

In recent years there have been between 8000 and 9000 personnel employed in the merchant navy, of whom about 2900 were officers. Almost all officers are permanent employees of ship operating companies and each company is responsible for the recruitment and career management of its officers. Ratings, in contrast, can be considered as industry, rather than company, employees and an institutional framework has been developed to balance manpower supply and demand. On a day-to-day basis the balance is achieved by a formal engagement system (the Marine Cooks, Marine Stewards and Seamen's Engagement System). This system, which is administered by the Commonwealth with active co-operation from the shipping companies and the maritime unions, was designed to ensure an equitable allocation of berths among industry personnel and to decrease the administrative costs of hiring labour incurred by employers and the time and travel costs incurred by employees in the search for suitable berths.

In the longer term the supply-demand balance for ratings is maintained by trade union supervision of the number of recruits in each employment category. In the past it was common practice to meet shortfalls in manpower supply by recruitment of ratings and particularly officers from overseas, but now more emphasis is given to recruiting and training officer cadets and ratings from within Australia. For example, the Australian Maritime College was established in Launceston in 1980 to train deck and engineer officers. In August 1982 it was announced that formal training for ratings will also be provided at Launceston. Accordingly, one of the objectives of this study was to provide those responsible for the design and management of maritime training facilities with a better understanding of the recruitment, promotion and wastage characteristics of personnel in the industry. The size of future recruitment intakes is clearly important in the provision of training facilities.

The mobility and motivation of personnel as they moved between ships and shipping sectors were also examined in the course of the study. As officers are usually company employees their mobility is determined largely by company policy. For ratings the employment structure of the merchant navy does not guarantee stability of association with a ship but does maintain stability of employment in the industry. This work provides estimates of the frequency with which men changed ships and changed from one type of ship to another. The 'loyalty' of ratings to particular types of ships was also studied.

The data base for this study was the register of personnel records maintained by the Department of Transport in fulfillment of its responsibilities under the *Navigation Act* 1912 and Schedule 10 of the Maritime Industry Sea-going Award. Since 1975, annual reviews have been made of personnel in the industry but this is the first occasion a systematic analysis of manpower supply in the industry has been undertaken. No evidence has been obtained of a similar analysis of an overseas maritime industry. However, a British inquiry into shipping (Rochdale 1970) did address many of the broader issues affecting maritime manning policy.

In theory it would have been desirable to describe the workforce characteristics of each of the approximately 50 employment classifications in the industry. In practice this was not possible due to lack of data and because the small numbers of personnel in some classifications would have resulted in unacceptably large statistical errors. Instead the workforce was divided into 11 employment categories - deck officers, engineer officers, electrical and refrigeration engineers, radio officers, deck ratings, engine-room ratings, stewards, cooks, crew attendants, shipwrights and miscellaneous. In addition to these 11 employment categories, the terms officers and ratings are used frequently in this paper. The term 'officers' is used to describe deck and engineer officers, electrical and refrigeration engineers and radio officers and the term 'ratings' is used to describe the remaining categories.

HISTORICAL DEMAND FOR MANPOWER

Although no attempt was made in this study to forecast the future demand for manpower in the merchant navy, an understanding of historical manpower demand was essential to the analysis of workforce mobility described later. The following analysis of total manpower demand and the breakdown of demand into industry sectors may also assist the continuing debate on industry revitalisation.

Manpower demand is defined in this work in terms of the berths in the Australian merchant navy, which in turn is defined to be those ships covered by section 10 of the *Navigation Act* 1912. The demand for manpower was estimated from a knowledge of the ships in the industry at any time (DoT 1978-83) and the manning level of each ship. By considering the physical characteristics of each ship and the trade in which each ship was principally engaged, total demand was disaggregated into nine categories or industry sectors.

The total number of berths available in the merchant navy from 1977-78 to 1981-82 and the number of berths in each of the nine industry sectors are shown in Figure 1. It can be seen that the total number of berths remained relatively stable at about 3900. In terms of berths the two largest sectors were coastal bulk and tankers, which together constituted about 50 per cent of total manpower demand. In the period under study the overseas bulk sector recorded the highest average growth rate, followed by the offshore industry. The coastal bulk sector was the only one for which there was a decline in the number of berths available.

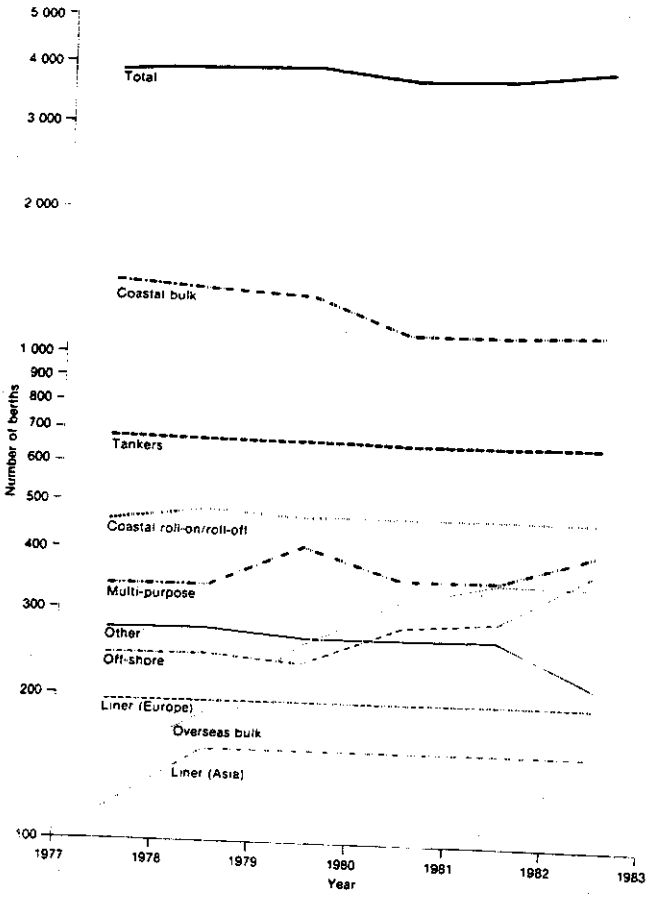

Figure 1. Historical demand for manpower in the Australian merchant navy

HISTORICAL WORKFORCE CHARACTERISTICS

Employment Levels

The total number of men employed in the merchant navy between 1976-77 and 1981-82 is shown in Figure 2, together with the numbers of officers and ratings employed in the same period. These estimates of the size of the workforce include the men who were occupying berths, the men on leave and the relatively small number of men waiting to be offered berths at any one time. It can be seen from Figure 2 that total employment in the industry varied between 8000 and 9000 in the six-year period. Officers and ratings represented about 35 and 65 per cent of the workforce respectively.

Figure 2. Employment levels; 1976-77 to 1981-82

It follows from the data in Figures 1 and 2 that about 2.2 men were employed for each available berth. This ratio reflects the fact that men were granted about one day's recreational leave for one day's work and the general need to employ a small number of additional men to allow for non-recreational leave such as sick leave. The slight increase in employment observed for ratings in 1981-82 is not reflected in the demand data in Figure 1 and was due to an increase in leave allowances and the subsequent need to employ more ratings.

Figure 3 is a schematic breakdown of the workforce by employment category. The data in Figure 3, which are averages over the six-year period, show that deck ratings were by far the largest category. It is interesting to note that about two deck ratings were employed for each deck officer but, in contrast, there were 50 per cent more engineer officers than engine-room ratings.

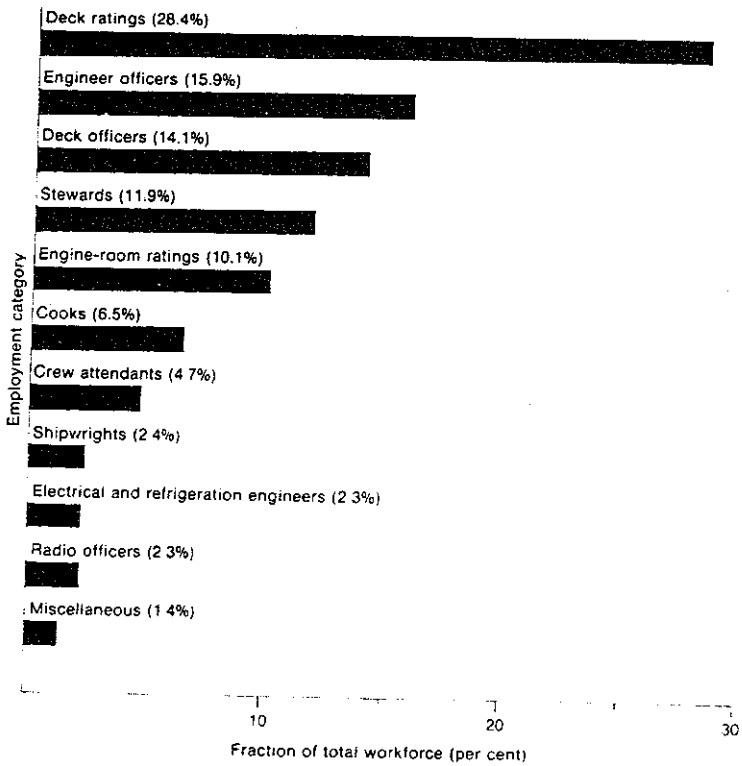

Figure 3. Composition of the workforce by employment category

Age Distribution of each Employment Category

Data were available on the age distribution of men in each employment category from 1977-/8 to 1981-82. The data were recorded in five-year age intervals. In the five-year period there was no evidence of statistically significant changes to the age distribution of any employment category and scatter in the distributions could therefore be reduced by averaging over time. The time-averaged age distributions for officers and ratings are shown in Figure 4. It can be seen that the forms of the distributions for officers and ratings were quite different: the most probable age of an officer was in the range 30 and 35 years whereas the most probable age of a rating was between 55 and 60 years. The average ages of officers and ratings were 39 and 42 years respectively.

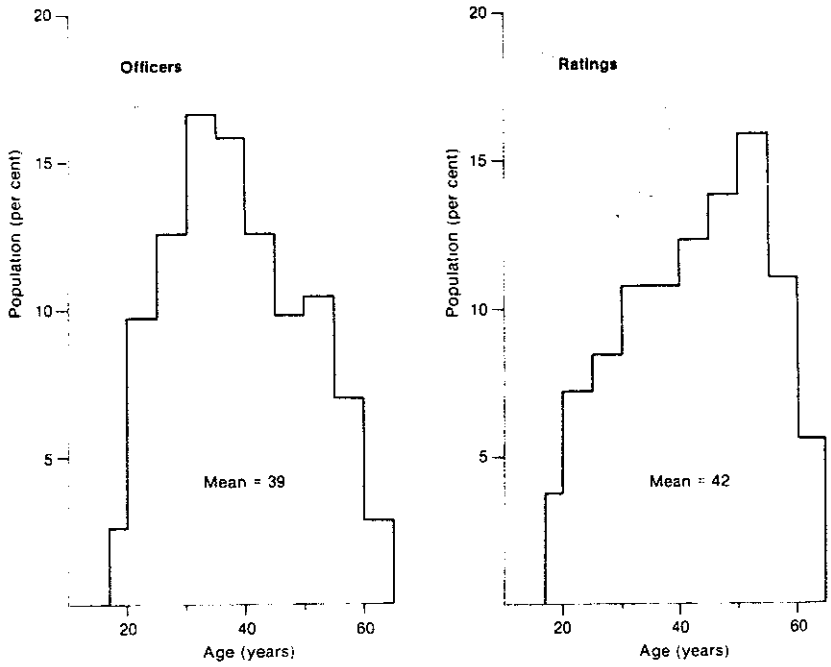

Figure 4. Age distributions for officers and ratings

Recruitment

The number and age distribution of recruits in each employment category were available for the period 1977-78 to 1981-82. As no significant changes with time were observed for any employment category the data for each category were averaged. The time-averaged recruitment distributions for officers and ratings, which are shown in Figure 5, indicate that the average age for officer recruitment was 32 years which was about the same as that for ratings (33 years). The most probable age of both officer and rating recruits was between 20 and 30 years.

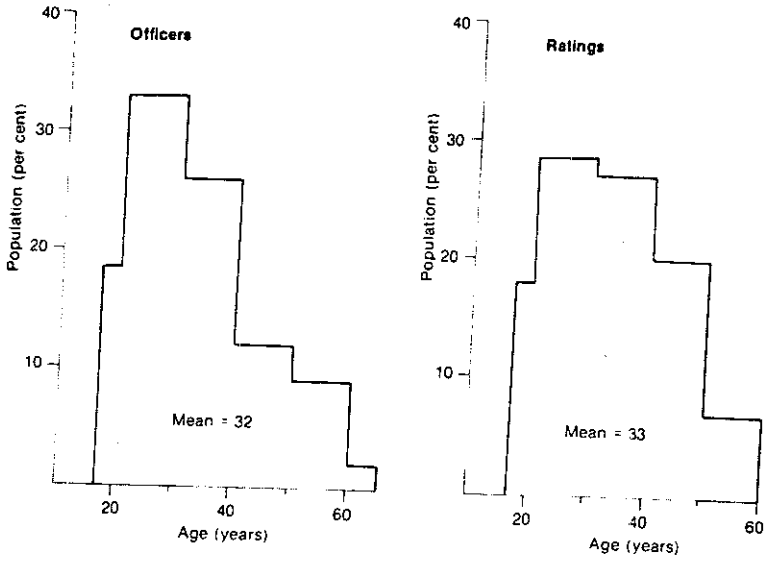

Figure 5. Age distributions of officer and rating recruits

Wastage

Details of manpower wastage in the maritime industry were not available from industry sources and it was necessary to derive wastage data from the general relationship,

$$\text{change in employment numbers} = \text{recruitment} - \text{wastage} \qquad (1)$$

Equation (1) was used to determine, for each employment category, the wastage probabilities of men in the age intervals <21, 21-30, 31-40, 41-50, 51-60, >60. Account was taken of aging and a description of how aging was included in the analysis is given later.

It was found that the wastage probabilities calculated using equation (1) varied markedly from year to year. While large annual variations in wastage probabilities may have been an inherent feature of the industry, it seemed likely that at least some of the scatter in the results was due to small errors in the employment data. This source of error was reduced by averaging the wastage probabilities over a number of years as any error in the employment data for one year affected the wastage probabilities for future and past years in opposite ways. Nevertheless it was only possible to derive reliable wastage data by averaging over employment categories or age groupings.

The wastage probabilities for officers and ratings are shown in Figure 6. The high probability of wastage for both officers and ratings over 60 years of age corresponded to retirement. It is interesting to note that the wastage data for either officers or ratings did not show the pronounced maximum at low ages often observed in manpower planning studies and caused by young people changing careers more frequently than their older colleagues.

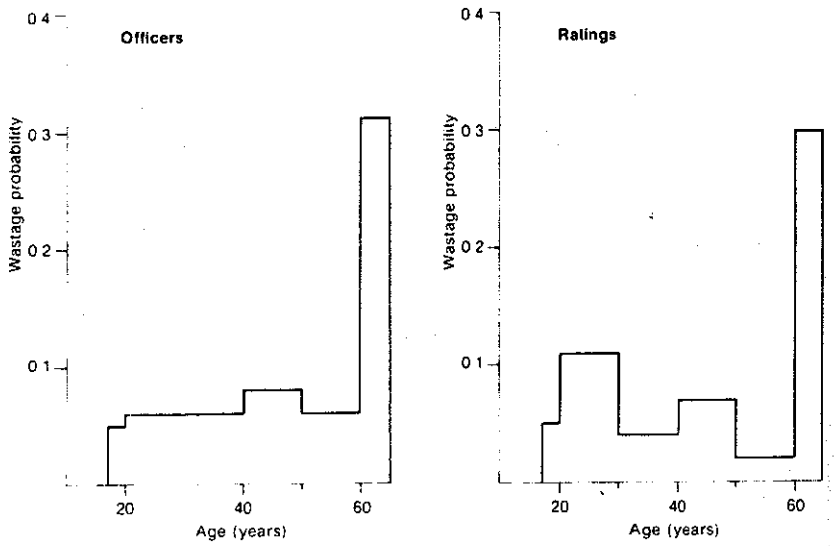

Figure 6. Wastage probabilities for officers and ratings

From the wastage probability data and the age distribution data (refer Figures 4 and 6) estimates were made of the annual wastage of men from individual employment categories. These annual wastage rates, which are listed in Table 1, represent averages over the period 1977-78 to 1981-82. There was, for example, an average annual wastage of deck officers of 6 per cent. No significant differences between the wastage rates for any employment category were observed and in general the rates were consistent with the rates experienced in many shore-based industries (ABS 1982).

TABLE 1 - ANNUAL WASTAGE RATE FOR EACH EMPLOYMENT CATEGORY

Employment category	Wastage rate
Officers	
Deck officers	0.06
Engineer officers	0.08
Average	0.07
Ratings	
Deck ratings	0.07
Engine-room ratings	0.08
Stewards	0.07
Cooks	0.08
Average	0.07

Source: Derived from data supplied by the Department of Transport.

Promotion

When discussing the promotion of men within career structures in the maritime industry it is necessary to stress the distinction between manpower supply and demand. The supply of manpower at each career level is measured in terms of the number of men who have the appropriate formal qualifications. Promotion, in the supply sense, thus corresponds to the admission to a higher qualification and may not necessarily involve greater responsibility or remuneration. In contrast the demand for manpower is measured in terms of the number of berths for men with the qualifications required to fill the position. Thus promotion in the demand sense need not necessarily involve a change in qualification. In fact many promotions are temporary as an individual with, for example, Masters qualifications may serve on one ship as a Master and on the next ship as a 1st Mate or even a 2nd Mate. In this study the emphasis was on manpower supply and therefore an individual was said to be promoted when he obtained higher formal qualifications.

No attempt was made in this work to model the fine details of the numerous possible career paths of deck and engineer officers. An important factor in this decision was that the necessary historical data would have been very costly to collect. Thus the model of the future supply of officers was limited to a broad description of career structures. The career path for deck officers was taken to be Cadet-2nd Mate-1st Mate-Master and the career path for engineer officers was taken to be Cadet-Engineer Class 2-Engineer Class 1.

The promotion probabilities were obtained by dividing the number of men in each age interval who obtained the relevant qualifications in a given year by the total number of men in the same age group who were eligible to apply for promotion in that year. It was assumed that the promotion probabilities were time-invariant over the period 1978 to 1982 and the results were averaged. The results are shown for deck and engineer officers in Table 2; for example there was a probability of 0.2 that a 1st Mate aged between 31 and 40 would be promoted to Master in the next year.

TABLE 2 - PROMOTION PROBABILITIES FOR DECK AND ENGINEER OFFICERS

Promotion Path		Officer age group				
From	To	21-30	31-40	41-50	51-60	>60
1st Mate	Master	0.14	0.20	0.09	0.05	0.00
2nd Mate	1st Mate	0.27	0.09	0.00	0.00	0.00
Cadet	2nd Mate	0.68	0.00	0.00	0.00	0.00
Engineer Class 2	Engineer Class 1	0.35	0.32	0.17	0.10	0.00
Cadet	Engineer Class 2	0.22	0.25	0.21	0.06	0.00

Source: Derived from data supplied by the Department of Transport.

THEORETICAL BASIS OF MANPOWER PLANNING MODEL

This section presents a theoretical approach to manpower planning and outlines the decision to model the supply of sea-going manpower with Markov chain techniques, which describe in probabilistic terms the behaviour of a system over equally spaced time intervals.

A common basis for an analysis of this type is to describe the organisation as a dynamic system of stocks and flows (Bartholomew and Forbes 1979). All members of the organisation are subdivided into groups on the basis of attributes such as age and rank and it is assumed that all individuals in the same group have the same aging, promotion and wastage probabilities. This basic approach is then incorporated into a model of the manpower system by satisfying the organisational constraints.

In some organisations (a public service department is a good example) the number of jobs in each grade is fixed and promotions and recruitment can only take place to fill vacancies as they occur. The models which describe this type of organisation are known as renewal or top-down models as wastage from the higher levels of the organisation 'drives' the system by creating vacancies to be filled by promotion and recruitment.

In a manpower system such as the Australian merchant navy the supply of men in each grade is variable. There are, for example, many more officers with Masters qualifications than there are berths for Masters and it is common

for 1st Mates to have Masters' qualifications. In addition, the number of men who qualify as Masters each year is not directly related to the number of berths for Masters as there are incentives (such as study leave) for each individual to gain further qualifications. In these circumstances the model must be 'driven' from the bottom by the process of recruitment. Markov chain theory can be used as the basis for models of this type if it can be validly assumed that the flow from one group to another is proportional to the stock in the first group.

The basic equation for a Markov chain analysis of a manpower organisation can be written

$$\underline{n}\,(T+1) = \underline{n}\,(T)\,\underline{P} + R(T+1)\,\underline{r} \qquad (2)$$

where $\underline{P}$ = transition matrix with elements p_{ij}, the probability that an individual in group i at time T is in group j at time T+1;
$\underline{n}\,(T)$ = vector of elements $n_i(t)$, the stock in group i at time T;
$R(T+1)$ = total recruitment in the time interval (T, T+1);
$\underline{r}$ = vector of elements r_j, the fraction of recruits entering group j.

The wastage of men from the organisation is not explicitly included in equation (2) but is included implicitly as the probability of wastage from group i, w_i, is related to the row elements of the transition matrix $\underline{P}$ by:

$$\Sigma_j p_{ij} + w_i = 1 \quad \text{for all } i \qquad (3)$$

The first steps required to implement the theory embodied in equations (2) and (3) are to define each of the groups and to determine the elements in the transition and recruitment matrices. In practice these steps are carried out iteratively because the choice of groups depends on data availability.

In this analysis the groups were generally defined on the basis of employment categories and age intervals. For the employment categories which do not have rank structures based on academic qualifications (for example ratings) it was only necessary to classify personnel by age as only rarely do ratings move from one employment category to another. For officers, however, it was necessary to include career structures in the model and each age group was therefore divided into sub-groups to allow for career hierarchy.

The data requirements can therefore be summarised in the following terms. For each employment category (including officer) the age distribution of manpower supply, recruitment and wastage was required. For officer categories data were also required on the promotion probabilities as a function of age.

SUPPLY OF RECRUITS REQUIRED TO SUSTAIN INDUSTRY GROWTH

It was shown earlier that over the six-year period 1976-77 to 1981-82 the workforce characteristics of the industry remained essentially stable. Given the changes which are presently occurring in the industry it can be argued that this stability will not continue and this chapter discusses the effects of changes to some previously stable characteristics of the maritime workforce. Particular attention is paid to the implications of industry growth on recruitment numbers and the effects of changing the age distributions of recruits. The techniques used in this analysis have been described earlier.

Results for Officers and Ratings

The implications for recruitment of different industry growth rates and recruitment practices are now described. In all the calculations it has been assumed that wastage probabilities will be maintained at their historical levels.

Each employment category was examined with two recruitment strategies. In the first, recruitment age distributions were set at their historical levels and, in the second, recruits entered only in the lower age categories. Specifically in the second strategy, all officer recruitment was assumed to occur in the 20 and under age group in the least-skilled employment category and, for ratings, recruitment was assumed to be equally split between the 20 and under and the 21 to 30 age groups.

The industry growth patterns considered were zero growth, a 5 per cent per annum increase and a 5 per cent per annum decrease for both officers and ratings. The numbers of recruits required to sustain these growth rates are shown in Figures 7 to 9 for ratings, deck officers and engineer officers respectively. In these figures, the continuous and broken curves show the results for the historical and alternative recruitment distributions respectively.

The effect of changing the recruitment distribution for ratings is qualitatively the same for all growth rates. For zero growth, the number recruited increases at first, then levels off at a value above the initial number, with the alternative recruitment distribution curve rising to a higher value before stabilising. In the 5 per cent decrease case, the initial number recruited is less than a third that for zero growth. The results for both recruitment distributions initially increase, with the alternative recruitment distribution curve again rising higher; both curves then decrease gradually towards zero. Initial recruitment in the 5 per cent growth case is just under twice that for zero growth. Both curves have an exponential shape, with the alternative recruitment pattern producing a faster rate of increase.

Similarly, the results for deck and engineer officers have a common pattern (see Figures 8 and 9). For zero growth, the required number of deck and engineer officer recruits per annum was found to be almost constant with time for both the historical and alternative recruitment age distributions. In the case of a 5 per cent decrease per annum the initial number of recruits required was calculated to be only about a third of those required for zero growth. Also the number of recruits required for each officer category was almost independent of the recruitment age distribution. For positive growth of 5 per cent per annum slightly smaller numbers of recruits were required in the case of the alternative recruitment age distribution.

The effects that changes to the recruitment age distributions would have on the age distribution of the workforce can be deduced from Table 3. This table gives a comparison for deck officers, engineer officers and ratings, between the mode (most probable) and the mean (average) of the current age distributions and the age distributions in ten years time if historical or alternative recruitment patterns prevail.

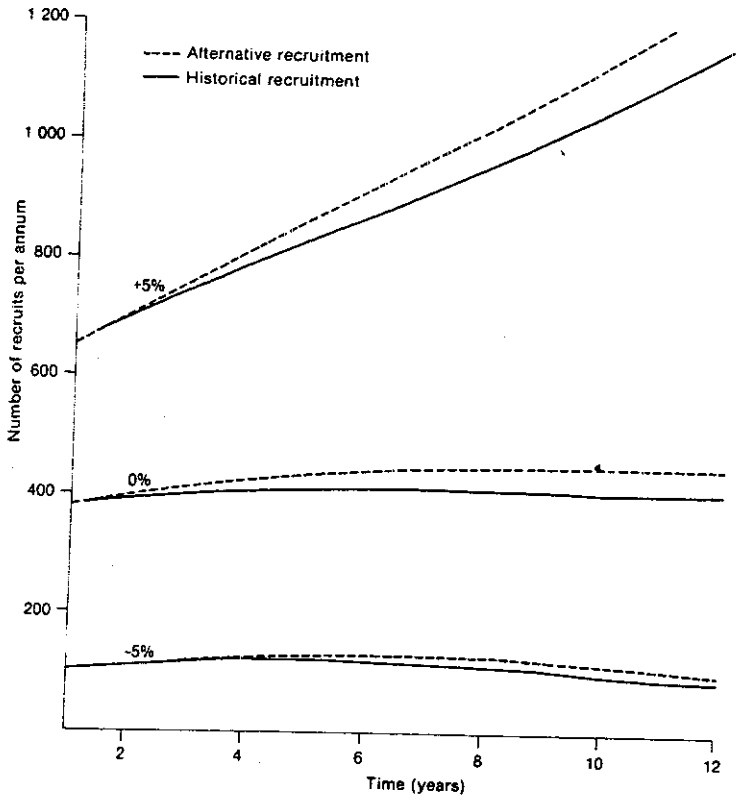

Figure 7. Recruitment required to sustain industry growth; ratings

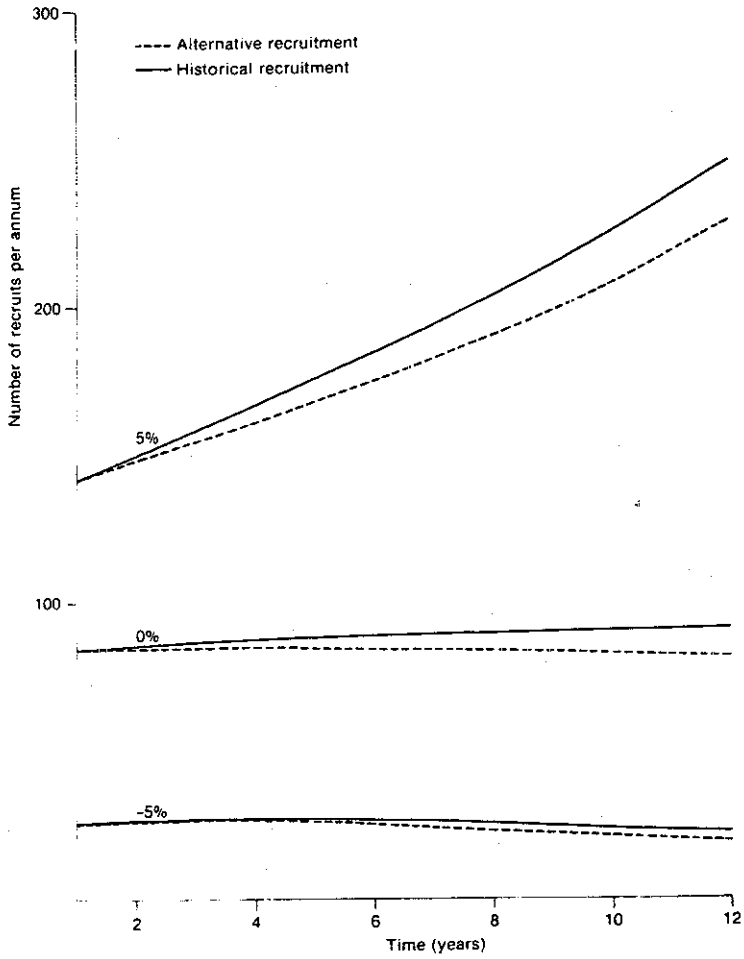

Figure 8. Recruitment required to sustain industry growth; deck officers

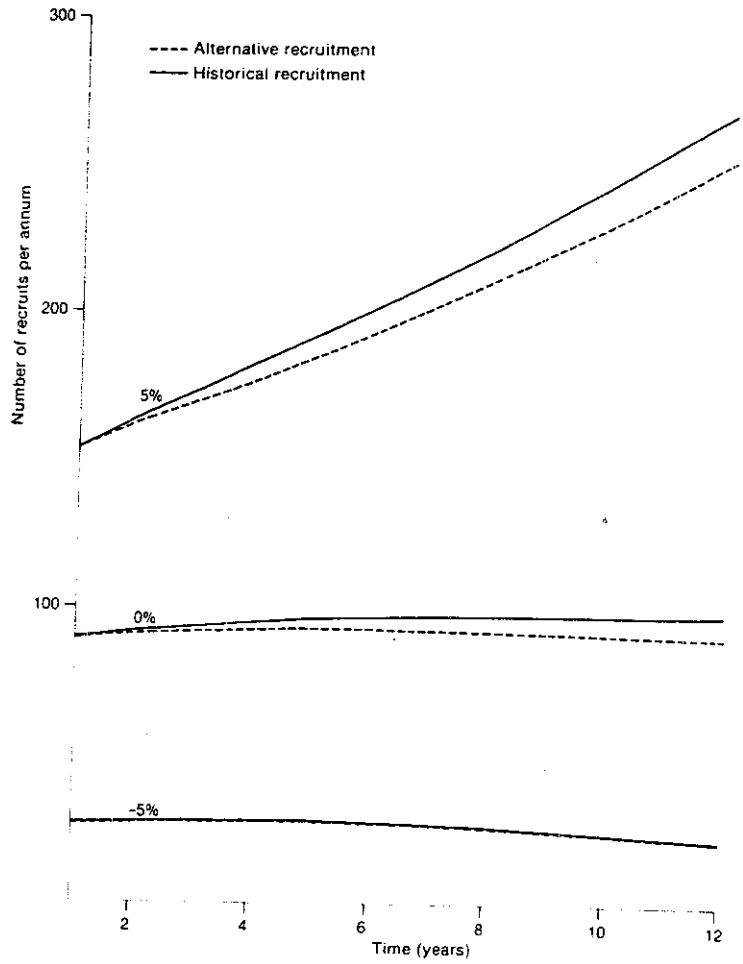

Figure 9. Recruitment required to sustain industry growth; engineer officers

TABLE 3 - COMPARISON OF THE AGE DISTRIBUTIONS OF OFFICERS AND RATINGS UNDER DIFFERENT RECRUITMENT STRATEGIES AND ANNUAL GROWTH RATES

Employment category	-5% growth Mode (years)	-5% growth Mean (years)	0% growth Mode (years)	0% growth Mean (years)	5% growth Mode (years)	5% growth Mean (years)
Deck officers						
current distribution	31-40	38	31-40	38	31-40	38
distribution in year 10						
historical recruitment	31-40	43	31-40	40	31-40	40
alternative recruitment	31-40	40	21-30	33	21-30	32
Engineer officers						
current distribution	31-40	38	31-40	38	31-40	38
distribution in year 10						
historical recruitment	31-40	41	31-40	39	31-40	37
alternative recruitment	31-40	41	31-40	34	21-30	32
Ratings, total						
current distribution	51-60	43	51-60	43	51-60	43
distribution in year 10						
historical recruitment	51-60	46	31-60	43	31-40	40
alternative recruitment	51-60	43	21-30	37	21-30	33

Source: Derived from data supplied by the Department of Transport.

The results in Table 3 indicate, that if historical recruitment and wastage patterns are continued in the future and the industry growth rate varies between plus and minus 5 per cent per annum, there are likely to be only relatively small changes in the age distributions of officers and ratings in the next ten years. For example, if a zero growth rate is experienced over the next ten years, the average ages of deck officers, engineer officers and ratings appear likely to change by less than two years. Slightly larger changes are likely if positive or negative growth rates are experienced in the industry. Negative growth rates by themselves would increase the average age of the workforce and positive growth rates would have the opposite effect.

Table 3 also shows that a reduction in the average age of recruits (alternative recruitment strategies) would result in reductions in the average ages of deck officers, engineer officers and ratings. This effect can be seen by comparing the results for the alternative and historical recruitment strategies after ten years. In particular, with industry growth of five per cent, decreases in the average ages of the three groups of between 13.5 and 20 per cent, together with a drop in the most likely age from between 31 and 40 to between 21 and 30, would be the results of employing the alternative recruitment strategies.

In summary, the results of this section indicate that any future reduction in the average age of recruits is likely to slowly reduce the average age of the workforce but it is unlikely to significantly affect the number of recruits required to sustain industry growth of less than 5 per cent per annum. The future growth rate of the industry will also affect the average age of the workforce. For example, positive industry growth would probably result in a decrease in the average age of the personnel in each employment category.

LABOUR MOBILITY IN THE MERCHANT NAVY

Background

The aim of this section is to describe the historical movement of men from ship to ship and from one type of ship to another in the five-year period 1977 to 1981. The emphasis is mainly on ratings as they were usually employed on a casual basis and thus were able to largely control their own mobility. In contrast, officers were usually company employees and their mobility was largely determined by company policy.

The technique used to describe workforce mobility is introduced with the aid of Figure 10, which illustrates an individual's work history. In Figure 10, b_x represents the time between first joining ship x and leaving ship x for another ship. The time b_x, or ship survival time, includes periods of leave taken between voyages on ship x. The time l_x represents the period of leave between service on ships x and x+1. The calendar time at which the individual joined ship x is denoted by t_x. The time s_x is the sector survival time, that is, the continous period of time the individual is employed on ships of the same type. Sector survival times include periods of leave taken between voyages on the same ship and between voyages on ships of the same type. In Figure 10 it is assumed that ships 2 and 3 are the same type and different from ship 1 and ship 4.

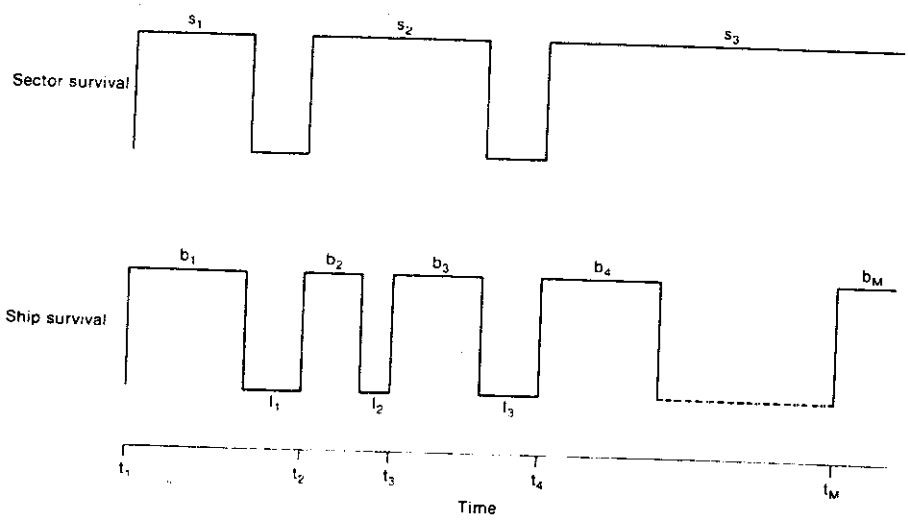

Figure 10. Representation of an individual's work history

Using these definitions a ship transfer rate equal to $(M-1)/(t_M-t_1)$ could be determined for each individual. A distribution of ship transfer rates could then be determined for a class of men and used, for example, to estimate the fraction of men who changed ships on average less than once per year. The probability that a crew member stayed on a ship for say three months, or equivalently the fraction of a new crew which were still on a ship after three months, is given by the distribution of ship survival times (b_x in Figure 10). A comparison between the distributions of ship and sector survival times provided information on the 'loyalty' of individuals to ships of one type.

Inter-ship Mobility

The ship transfer rate distributions for ratings and officers are shown in Figure 11. It must be remembered when comparing these distributions, which represent averages over the five-year period 1977 to 1981, that officer mobility was determined largely by company policy and the mobility of ratings was determined by individual motivation. It can be seen that 60 per cent of ratings and 52 per cent of officers changed ship on average less than once per year. The difference between the distributions is larger at higher ship transfer rates. For example 15 per cent of ratings and 4 per cent of officers changed ship more than three times per year on average.

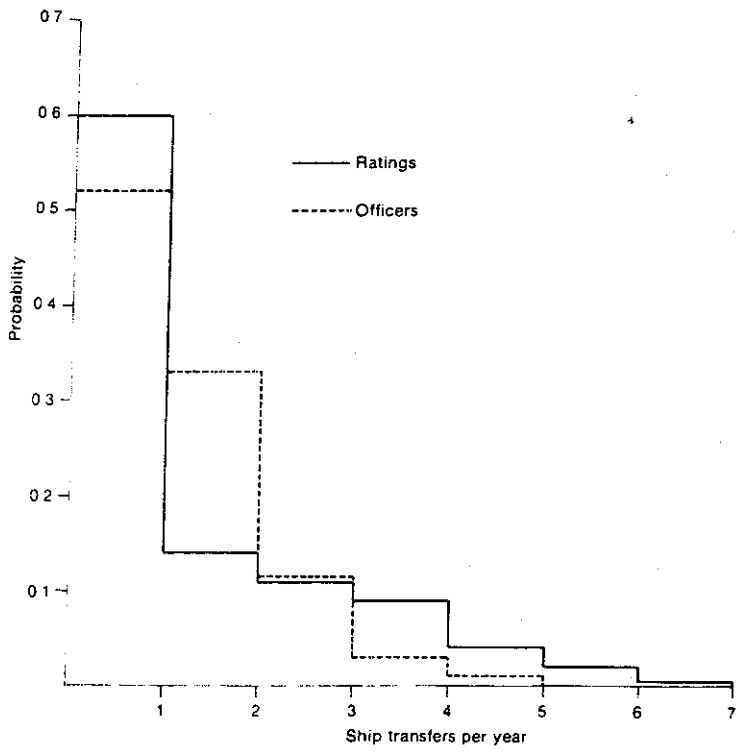

Figure 11. Ship transfer rate distributions for officers and ratings

The probability that a rating changed ship in a specific month-long interval is shown by the solid curve in Figure 12. There was a probability of about 0.30 that a rating changed ship after one month but before two months, and a probability of about 0.21 that he changed ship after 12 months. The major difference between this curve for ratings and the equivalent curve for officers (broken curve in Figure 12) is in the probability of changing ship within the first two months. After two months 50 per cent of a new crew of ratings had changed ship but only 25 per cent of a new crew of officers had changed ship.

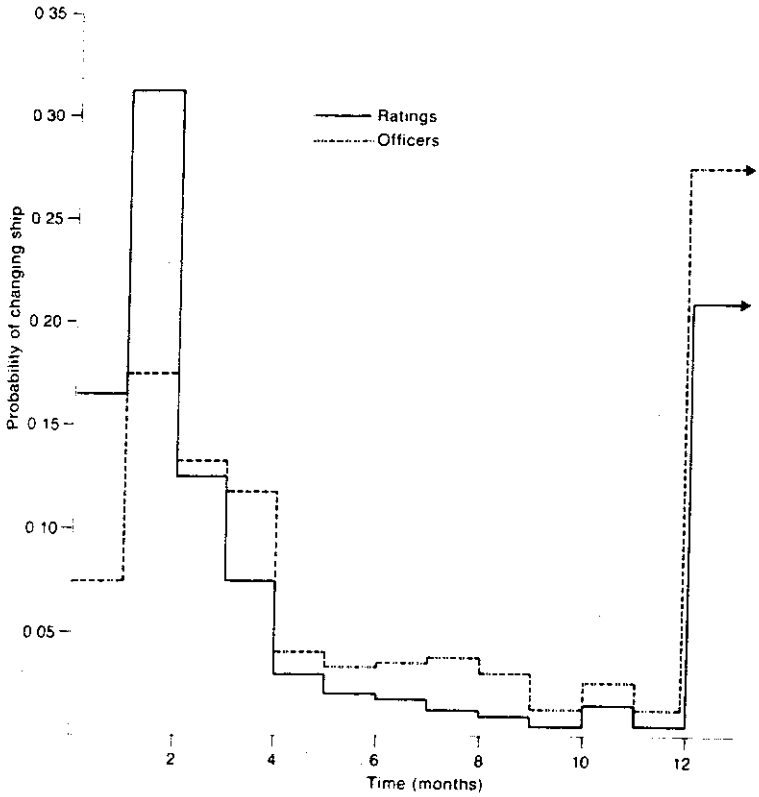

Figure 12. Ship change probability distributions for officers and ratings

Table 4 summarises the times spent by ratings on ships in each sector. For example there was a probability of 0.32 that a rating employed on a tanker stayed on the same ship for at least 24 months. Similarly there was a probability of 0.25 that a rating employed on a ship in the overseas bulk trade stayed on the same ship for at least six months. The data in Table 4

give estimates of the relative popularity of ships in the different industry sectors. The reason why tankers appear to have been the most popular type of ship may have been partly due to the relatively high rates of pay awarded to tanker crews. However, rates of pay cannot have been the only reason as the crews of offshore industry vessels were also paid at above average rates.

TABLE 4 - SHIP SURVIVAL PROBABILITIES FOR RATINGS IN EACH INDUSTRY SECTOR

Sector	Probability of survival			
	At least 3 months	At least 6 months	At least 12 months	At least 24 months
Tankers	.46	.41	.38	.32
Other	.41	.34	.22	.15
Liner (Europe)	.69	.29	.20	.14
Liner (Asia)	.41	.28	.20	.13
Coastal roll-on/roll-off	.34	.26	.18	.13
Offshore	.48	.35	.23	.12
Coastal bulk	.37	.21	.15	.11
Multi-purpose	.37	.24	.14	.10
Overseas bulk	.41	.25	.18	.09

Source: Derived from data supplied by the Department of Transport.

A specific statistical technique known as the Kolmogorov-Smirnov test (for example, see Conover (1971)) was used to test for statistically-significant differences between the survival functions for ships in each sector. It was found that, at the 10 per cent level, only two functions were different from the others. The survival function for tankers was different because survival was high on these ships (probably partly due to higher rates of pay). The survival curve for liners travelling to Europe was different because of the high probability of survival on the same ship for at least three months (as would be expected for the relatively long voyage to Europe).

Inter-sector Mobility

So far the results reported have referred only to inter-ship transfers. The discussion is now extended to inter-sector transfers. If a rating always changed sector when he changed ship then the sector survival function would coincide with the ship survival function for that sector. Under no circumstances could a sector survival function fall below the ship survival function of that sector because sector cannot be changed before ship. If, however, choice of sector was a random process then the sector survival function would lie above the ship survival function as there is a finite probability that an individual would serve consecutively on two or more ships in the same sector. If the observed sector survival function lies significantly above the 'random' sector survival curve then sectoral loyalty would exist for that sector.

Figure 13 enables a comparison to be made between the ship, 'random' sector and observed sector survival functions for the coastal bulk sector. For this and the other sectors the Kolmogorov-Smirnov test was used to examine the hypothesis that the observed sector and random sector functions were equal. In all cases except one the hypothesis was not rejected at the 20 per cent level and it was therefore concluded that ratings did not show loyalty to any of these sectors. In the case of the coastal bulk sector the hypothesis was rejected at the 2 per cent level and it was concluded that ratings exhibited loyalty to this sector.

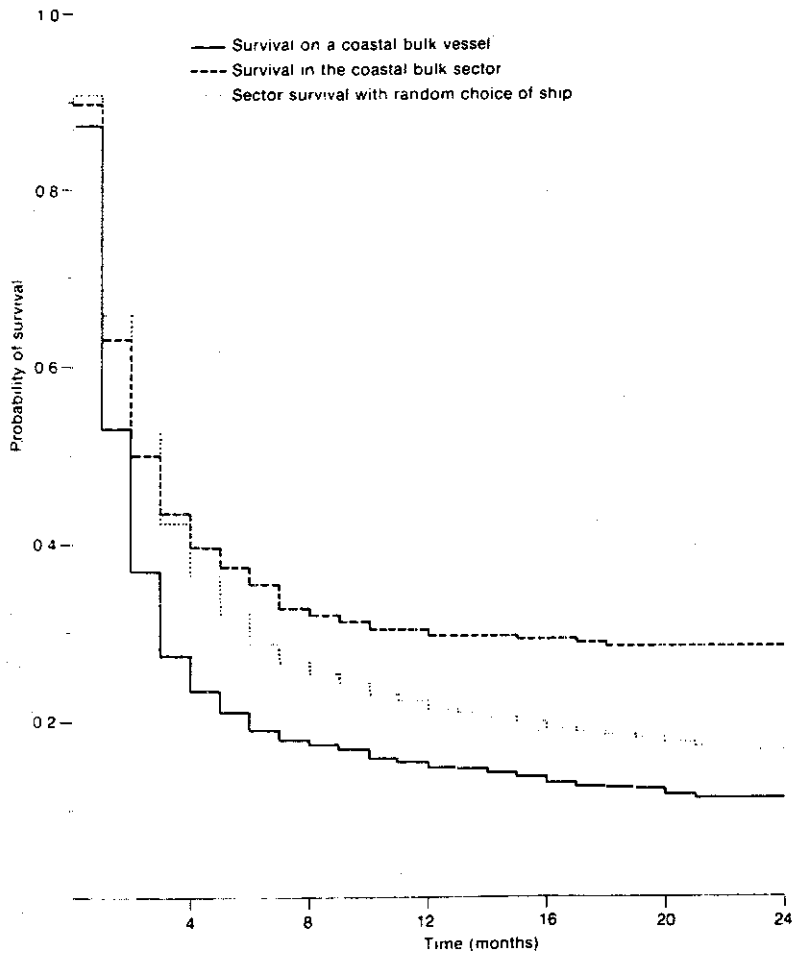

Figure 13. Ship and sector survival functions for ratings in the coastal bulk sector

No explanation is offered for the fact that loyalty was observed only in the coastal bulk sector. It should be noted, however, that the relative sizes of the industry sectors were taken into account in this analysis and therefore the existence of loyalty in only the largest sector was purely coincidental.

The general lack of loyalty was interpreted to mean that a typical seaman chose ship type on a random basis. The workforce therefore did not consist of groups of men who worked on specific types of ship, except for one group who worked on coastal bulk vessels.

CONCLUDING REMARKS

In the period 1977 to 1982 the total number of berths available for men in the Australian merchant navy remained almost constant, although there was a significant reduction in the number of berths in the coastal bulk sector and significant increases in the number of berths in the overseas bulk and offshore sectors. In this period there was no evidence of change in the age distribution of men in the industry or in the age distributions of recruitment or wastage. Thus if historical employment patterns remain unchanged in the future there will only be very small changes in the industry's workforce characteristics.

Any future reduction in the average age of recruits is likely to result in a small, slow decrease in the average age of the workforce but it is unlikely to have any major effect on the number of recruits required to sustain industry growth. The future growth rate of the industry will also affect the average age of the workforce. If recruitment and wastage patterns do not vary in the future then positive industry growth would result in a decrease in the average age of the workforce and negative growth would have the opposite effect.

The average wastage rate for both officers and ratings in the period 1977 to 1982 was 7 per cent per annum.

It has been shown that a large fraction of both officers and ratings stayed on the same ship for extended periods; 60 per cent of ratings and 52 per cent of officers changed ship less than once per year on average. However the men who transferred frequently between ships caused crew turnover rates to be high; on average 50 per cent of a new crew of ratings transferred to another ship in the first two months. Ship transfer rates decreased with increasing rating age

It was found that crew turnover depended strongly on industry sector, with the lowest turnover observed for tankers and the highest for overseas bulk vessels. Ratings exhibited 'loyalty' only to coastal bulk vessels and it was concluded that in general the workforce did not consist of groups of men who worked on specific types of ships.

REFERENCES

ABS (1982), Labour mobility during the period February 1980 to February 1981, Catalogue No 6209.0, Australian Bureau of Statistics, Canberra

Bartholomew, D.J. and Forbes, A.F. (1979), Statistical techniques for manpower planning, John Wiley and Sons, Chichester

Conover, W.J. (1971), Practical nonparametric statistics, John Wiley and Sons Incorporated, New York.

Crawford, T.G. (1982), Revitalisation of Australian shipping; an overview, Australian Government Publishing Service, Canberra

DoT (1978-83), Australian shipping and shipbuilding editions 30 to 35, Department of Transport, Australian Government Publishing Service, Canberra

Rochdale (1970), Committee of inquiry into shipping, Her Majesty's Stationery Office, London