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RESEARCH MEMORANDUM

AN ANALYSIS OF THE ACTIVE DUTY SERVICE OBLIGATION (ADSO) FOR NAVY PILOTS

Donald J. Cymrot
Patricia E. Byrnes

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Because of persistent shortages of personnel to fill instructor billets in the aviator community, the active duty service obligation (ADSO) for naval aviation officers was increased on 1 July 1987. Newly commissioned officers in the aviation community are now required to make a six-year commitment to the Navy after receiving their wings. This change has prompted policymakers to ask about the optimal minimum service requirement. This research memorandum analyzes the ADSO for Navy pilots. The analysis included the development of a model that captures the effect of changes in the ADSO on the total compensation and training costs of pilots through the first 15 years of service.

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AN ANALYSIS OF THE ACTIVE DUTY SERVICE OBLIGATION (ADSO) FOR NAVY PILOTS

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ABSTRACT

Because of persistent shortages of personnel to fill instructor billets in the aviator community, the active duty service obligation (ADSO) for naval aviation officers was increased on 1 July 1987. Newly commissioned officers in the aviation community are now required to make a six-year commitment to the Navy after receiving their wings. This change has prompted policymakers to ask about the optimal minimum service requirement. This research memorandum analyzes the ADSO for Navy pilots. The analysis included the development of a model that captures the effect of changes in the ADSO on the total compensation and training costs of pilots through the first 15 years of service.

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EXECUTIVE SUMMARY

Because of persistent shortages of personnel to fill instructor billets in the aviator community, the active duty service obligation (ADSO) for naval aviation officers was increased on 1 July 1987. Newly commissioned officers in the aviation community are now required to make a six-year commitment to the Navy after receiving their wings. The change in the ADSO from five to six years has prompted policymakers, most notably the Secretary of the Navy, [1] to ask for information about the optimal active duty service obligation. In order to consider the question, the Aviation Community Active Duty Service Obligation (ADSO) model was developed. The purpose of this research memorandum is to describe the model and to provide information about its uses and limitations.

The ADSO model is a steady-state model, which focuses on the total cost and total input requirements sufficient to fill key billets during the first 15 years of an aviator's career under alternative values of the aviator ADSO. The main features of the model can be summarized as follows.

- The model is based on the assumption that the aviation community should be shaped by the requirement to fill the first shore tour (instructor tour) and the third sea tour (department-head tour). In the model, only one of these constraints can be binding at a time. The binding constraint is used to determine the number of aviators to recruit.

- The number of accessions needed to meet requirements depends not only on billet requirements but on aviator retention behavior. In the model, a distinction is made between continuation at the end of active obligated service (EAOS) and continuation not at the end of active obligated service (non-EAOS). EAOS continuation rates are determined by the level of pay, allowances, and bonuses and the values of economic variables entered in the model. The non-EAOS continuation rates are entered directly into the model.

1. Secretary of the Navy Memorandum, *Active Duty Obligation for Aviators*, 5 August 1987.

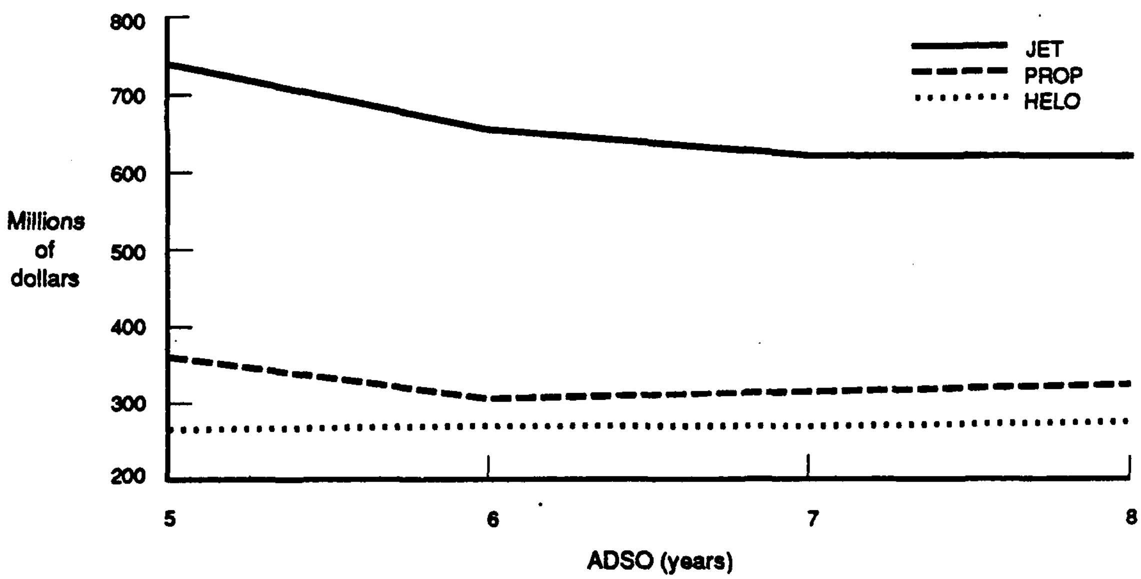
- In considering changes in the active duty service obligation, the chief negative concern is its effect on recruiting. An increase in the active duty service obligation is likely to reduce the attractiveness of aviation to some potential recruits. This is reflected in the model as decreases in the attrition rate from flight school.

Simulation models, such as this one, are best used to study the sensitivity of changing various inputs on the outputs. Through successive runs of the model, patterns emerge that can help policymakers and planners understand certain tradeoffs. This analysis uses current cost of training, pay, allowances, bonuses, billet structure, and continuation behavior.

The three aviation communities—jets, helicopters (helo), and propeller (prop)—differ in three key areas: cost of training, billet structure, and continuation. Because of the differences, the model has been configured to treat the three communities separately. The model output for the three communities is given in the following figure, which shows the relative cost of the four different ADSOs for each of the three communities. The minimum-cost ADSO is different in each of the three cases. Because the pilot communities differ in model inputs, analyses of the outputs across the communities provided useful insights. The results of this analysis can be summarized as follows:

- The shortage of pilots in the first shore tour is most acute in the jet community. Consequently, under most circumstances the first shore tour is the binding constraint. In this situation, there is a cost advantage for retaining pilots until they have completed their shore tour because lower attrition permits a reduction in the training rate and inventory for the first sea tour. Since increasing the inventory is costly, increasing the ADSO reduces the overall community costs. The total cost increases after seven years for two reasons. One, the model assumes a cost associated with increases in the ADSO in the form of higher attrition from flight school. Two, retaining a large pre-ADSO inventory beyond the first shore tour is costly.

- On the opposite extreme from the jet community is the helo community, where the cost-minimizing ADSO is at five years. Given the structure of billets in the helo community, the binding constraint is the department-head tour. Increasing the ADSO to any reasonable level does not address potential shortages of department heads because under the current career path the department-head tour is completed at YOS 14 or 15, which is well beyond the first decision point.



Total annual cost of pilots to YOS 15, by ADSO and community

- The intermediate case is in the prop community, where an increase in the ADSO from five to six years causes a reduction in the total cost. Further increases in the ADSO lead to slightly higher total costs. The current requirements configuration in the prop community is such that a change in the ADSO from five to six years causes a shift in the binding constraint from the first shore tour to the department-head tour. This shift reduces the training requirements and thereby leads to cost savings. Further increases in the ADSO have the same effect in the prop community as they do in the helo community.

The results of the three communities can be combined in the model to provide an aggregate picture of all of aviation. The results of this analysis revealed that in most cases the least-cost ADSO is seven years. Given the current values of the model parameters, the requirement to fill first-term shore billets dominates. With an ADSO of seven years, most aviators complete the first shore tour before reaching their reenlistment-decision point. This point helps minimize the training rate, which is a major driver of the model. Changing the input values, even by relatively large amounts, generally did not change these results. However, the model is sensitive to changes, if small changes in variables cause a change in the binding constraint. Furthermore, the most likely way to alter the binding constraint is to change the billet structure. If the billet structure included relatively more department-head billets, the model would be more sensitive to input changes.

This model is a relatively simple representation of the aviation community, although the model provides useful information to answer questions about the optimal ADSO for aviators. Further work is required in a number of areas, including identifying other possible constraints, the effect of pay and other factors on retention, the cost of training, and the effect of changing the active duty service obligation on recruit quality.

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INTRODUCTION

A newly commissioned naval officer who wishes to become a member of the aviation community either as a pilot or a Naval Flight Officer (NFO) must agree to remain in the Navy for a minimum of six years after completing flight training. This requirement is known as the active duty service obligation (ADSO).[1] Prior to 1 July 1987 the ADSO was five years of service. With an ADSO of five years, many officers completed their required service during the first few months of the instructor tour and left the Navy without completing the tour. This attrition increased the requirement for instructors beyond their availability. By increasing the ADSO, the supply of officers is expected to increase, and the annual requirement is expected to decrease because fewer replacements will be needed to complete tours.

The change in the ADSO from five to six years has prompted policymakers, most notably the Secretary of the Navy [1], to ask for information about the optimal active duty service obligation. If a six-year ADSO is better than a five-year commitment, perhaps seven or more is better than six.

In order to consider the question of the optimal ADSO a working group was established under the auspices of OP-59, the Aviation, Manpower and Training Division of the Assistant Chief of Naval Operations for Air Warfare. This working group has been charged with providing the Secretary with information on optimal active duty service obligation. As part of that effort, the Aviation Community Active Duty Service Obligation (ADSO) model was developed. This model deals with certain aspects of this problem. Specifically, it focuses on the cost of providing sufficient officers to fill key billets during the first 15 years of an aviator's career. The total cost of the officer corps is shown to vary depending on the active duty service obligation. The purpose of this research memorandum is to describe the model and to provide information about its uses and limitations.

1. The active duty service obligation is sometimes referred to as the minimum service requirement (MSR).

OVERVIEW OF THE MODEL

The ADSO model is a steady-state model that determines aviator input requirements and costs of filling the requirements for the first shore tour (instructor) and for the third sea tour (department-head) for alternative values of the aviator ADSO. The model is not a programming model; it does not identify an optimal combination of policy inputs to achieve an idealized outcome. Rather it is an analytic tool that can be used to compute the total cost, total input requirements, and aviator-instructor and department-head requirements per year under different ADSOs. The size of these outputs and the differences across ADSOs depend on several policy-related and technical inputs. Through successive runs policymakers may become aware of certain interactions among aviator requirements policies, compensation policies, and changes in the ADSO.

The model is built into a Lotus 1-2-3 spreadsheet and is designed to provide flexibility in analyzing the ADSO question. A variety of inputs dealing with the billet structure, pay and bonuses, and continuation can be changed using a customized menu. However, certain components in the model's current configuration are fixed.[1] The built-in assumptions deal mostly with the aviation officer's career path. Officers are assumed generally to follow the career path described in the *U. S. Navy Unrestricted Line Officer Career Planning Guidebook* [2], although some provision has been made for varying the length of certain critical tours.[2]

AVIATION OFFICER CAREER PATH

Each community within the unrestricted line has a prescribed career path. This career path describes the types of assignments the officer will

1. Although these components could be modified with some reprogramming, they cannot be changed using the menu, and would likely require changing both the spreadsheet cells and the macros.

2. The aviation career path used in the model, and shown in figure 1, was the career path in effect at the time of the study. As a result of the ADSO study and other factors, the career path has changed.

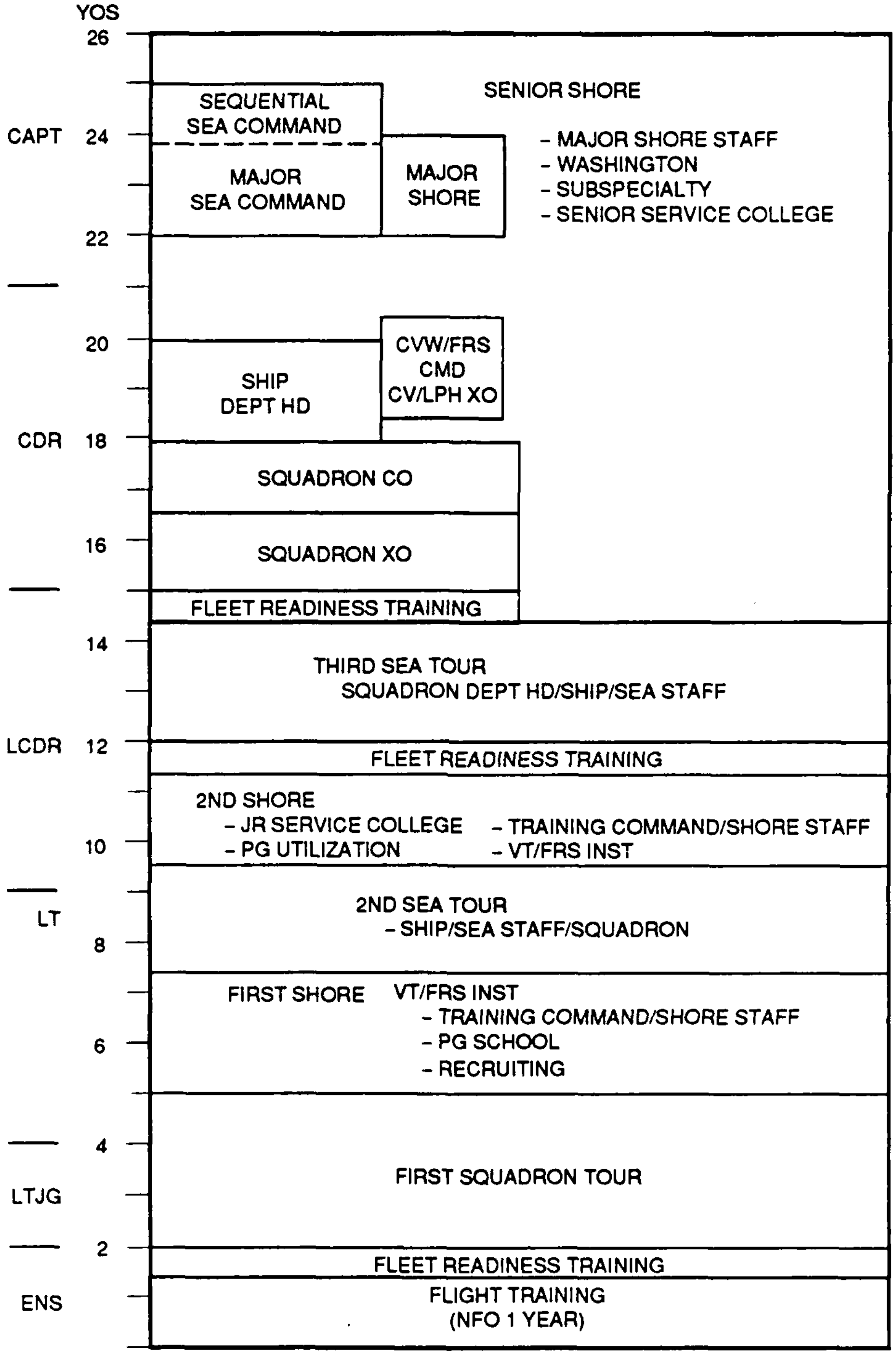

Figure 1. Aviation officer career path

have during different phases of his career through the rank of captain. Although not all officers follow this path exactly, career paths serve as a useful guide for portraying a community. The aviation officer's career path, shown in figure 1, is used as a basis for the model.[1] The time when each officer should be in a particular stage is given in years of commissioned service (YOS) on the left the figure. An important distinction is that completion of ADSO or end of obligated service is computed from the date the aviator completes training and not from the commissioning date. Thus, an ADSO of six years does not mean the end of obligated service is at YOS 6; rather it varies for aviators in the same year group, since the time it takes to complete training varies.

The first stage of a pilot's or NFO's career is flight training. The training curriculum is quite different for pilots and NFOs, and the time spent in training differs for both. Pilot training requires from 12 to 18 months, depending on the type of aircraft and student load within the training command. Since less flying time is required for an NFO, training time is shorter—about one year. Completion of training results in the awarding of wings and transfer of the designated officer to a Fleet Readiness Squadron (FRS).[2] The FRS provides operational training required for the first sea tour. The initial squadron tour lasts approximately three years. Aviators, in general, serve as squadron branch officers or division officers on the first sea tour.

The first shore tour starts at between 4 and 7 years of commissioned service and lasts about 30 months. The majority of the officers fill an instructor billet, although some fill other shore billets or are sent for professional development to the Naval Postgraduate School.

Another sequence of fleet and shore tours follows this initial phase. Ex-

1. Although the path illustrated in figure 1 is labeled for male officers, for the purposes of this model it is also applicable to female aviators. Female aviators follow the same sea-shore rotation cycle, including tour lengths, as their male contemporaries, except that their sea-duty assignments are within the force support. Ashore, female aviators are assigned to any aviation (13XX) billet for which they are qualified by grade and experience.
2. At this point, the officer starts to fulfill his active duty service obligation.

perience has shown that generally the number of aviators is sufficient to fill these billets. The next potential "choke" point occurs during the third sea tour in the requirement for department-head billets. In some cases an insufficient number of officers remain in the Navy to fill these billets. The department-head tours start at 12 years of commissioned service and last for 30 months. Thus, the department-head tour is completed sometime during YOS 15, which is the period covered by the ADSO model.

The career path plays a crucial role in the planning process. Varying the career path, or more specifically the tour length, can determine a shortage or surplus at various points. Lengthening the tour reduces the annual requirement for a type of billet. If each officer spends more time in a billet, a smaller number is required to fill the billet. Thus, an alternative to increasing the ADSO in dealing with shortages of instructors or department heads may be to increase the tour length for these billets. This model can be used to consider the cost implications of this tradeoff, although other factors,[1] outside the scope of this model, affect the tradeoff.

MOTIVATIONAL ASSUMPTION

The model is driven by the need to fill the instructor billets (in the first shore tour) and department-head billets (in the third sea tour). They are the constraints that motivate the model. The program determines which of the two constraints is binding under the current values of the inputs and determines the values of the outputs based on the binding constraint. Pilots and NFOs are treated separately, and each faces both constraints. It is possible for the instructor constraint to be in effect for pilots and the department-head constraint to be effective for NFOs or *vice versa*.

The program goes through a number of steps in determining the requirements. The user enters the number of billets of each type (instructor

1. A longer instructor tour may contribute to instructor "burnout," but it may also reduce the number of permanent-change-of-station (PCS) moves. A longer department-head tour reduces the number of aviators screening for command and thereby reduces the officer selectivity. Reduced selectivity may reduce overall effectiveness of leadership.

or department head) for both pilots and NFOs. The number of billets is then divided by the availability rate. The availability rate is the percentage of officers at this career stage that will fill this particular type of billet. For example, suppose 1,000 pilots are in their first shore tour in instructor billets, and 500 other billets are filled by first-shore-tour pilots. In this case the availability rate is 0.67. If 1,000 is filled in as the number of instructor billets, and 0.67 is the availability rate, then 1,500 pilots are needed to fill first-shore-tour billets. An alternative way of running the model is to assume an availability rate of 100 percent and enter all billet requirements for a first shore tour.

Other factors besides the availability rate influence aviator requirements. To continue with the example, 1,500 billets is not the annual requirement for pilots. This number is modified by two other factors—tour length and attrition. Since the average tour length is 2.5 years, a 1,500 total requirement converts to a 600 annual requirement. However, 600 pilots per year is not sufficient to fill all the billets if there is attrition. The 600-pilot annual requirement is divided by expected continuation over the 2.5 years to determine the attrition-adjusted annual requirement. For example, if only 80 percent of the pilots remain in the Navy between 5 and 7.5 years of service, the pilot instructor constraint is 750.

Annual requirements for department head are determined in a similar fashion. In this case the availability rate[1] is for the third sea tour, and the continuation rates are for years of service 12 through 14.5.

Once the annual input requirement for department heads is determined, the number of pilots required at five years of service to satisfy this requirement is determined. It is calculated by dividing the annual inputs by the continuation rate for each year back from 11 years of service through 5 years of service. For example, the department-head requirement at 11

1. Selectivity rate might be a more appropriate term here because officers are selected for department-head tours.

years, $DHReq_{11}$, is given by:

$$DHReq_{11} = \frac{DHReq_{12}}{CR_{11}} \quad .$$

Successive requirements are determined in a similar fashion until the fifth year is reached. The fifth-year requirement for department heads is used to determine which constraint is binding. If the fifth-year requirement for department heads is greater than the fifth-year requirement for instructors, then the department-head constraint is binding. If the fifth-year requirement for department heads is less, then the instructor constraint is binding. This methodology is illustrated in table 1. In this example the total requirement for instructors is 1,000, and the total requirement for department heads is 350. The first line of the table shows the continuation rate for the different years of service. An implicit assumption in these continuation rates is that the ADSO is five years. In this case the major decline in the attrition rate occurs in the sixth and seventh year of service. The second line shows the inventory required to fulfill the instructor requirement, given the continuation rates. The instructor billets are filled with inventory from YOS 5 and 6 and half the inventory of YOS 7 (431 + 409 + .5 * 319 = 1,000). The third line shows the inventory required to fulfill the department-head requirements, given the continuation rates. The department-head billets are filled from YOS 12 and 13 and half of the YOS 14 inventory (142 + 139 + .5 * 137 = 350).

Table 1

Derivation of Inventory Profiles for
Instructor and Department-Head Constraints

	Years of Service									
	5	6	7	8	9	10	11	12	13	14
Cont. Rate	.95	.78	.80	.85	.92	.95	.98	.98	.98	.98
Instructor	431	409	319	255	217	200	190	186	182	179
Depart. Head	380	313	244	195	166	153	145	142	139	137

NOTE: Instructor requirement is 1,000, and department-head requirement is 350.

A comparison of the two possible inventories indicates that the instructor requirement is the binding constraint. The inventory that just fulfills the department-head requirement produces an insufficient number of aviators to fulfill the instructor requirement. Using the inventory for the department-head constraint, the total inventory in the range to fill instructor billets is only 815 (380 + 313 + .5 * 244). Conversely, the instructor profile produces a surplus of inventory to fill department-head billets (458).

After determining which constraint is binding, the program calculates the number of pilots at each year of service from 0 (flight school inputs) through the completion of 15 years of service. Annual inventories are determined by applying annual continuation rates. The annual inventories are used to calculate the cost and training rates.

CONTINUATION RATES

A key factor in determining which of the two constraints is binding and the number of accessions required to meet requirements is the continuation rate for each year of service. In the model, a distinction is made between continuation at the end of active obligated service (EAOS) and continuation not at the end of active obligated service (non-EAOS).

EAOS continuation is assumed to depend on the level of pay, allowances, and bonuses and on conditions in the civilian economy. As the level of relative military pay increases, whether through pay or bonuses, the EAOS continuation rate increases. Conversely, increases in civilian pay or increases in civilian pilot hires lead to a decrease in the EAOS continuation rate. EAOS continuation is aimed at capturing only those decisions made after the pilot fulfills his active duty service obligation. All other attrition is assumed to be non-EAOS.

Non-EAOS continuation, which can take the form of attrition from the Navy or a lateral transfer within the Navy, is assumed to be independent of economic factors. A set of non-EAOS continuation rates are entered directly into the model, whereas the EAOS continuation rates are determined by the values of the economic variables entered into the model.

The total continuation rate combines the EAOS and non-EAOS rates. In most years, there are no officers reaching EAOS, so the combined rate is equal to the non-EAOS rates. In years that officers reach EAOS, the combined rates are the weighted average of the EAOS and non-EAOS rates, where the fraction of the officers reaching EAOS in a given year of service is used as the weight. For instance, if the minimum service requirement is 5 years, most pilots complete their ADSO in 6-1/2 years because flight school averages 18 months. If 80 percent of officers reach EAOS during this year, the combined continuation rate would be $.8^{*}CR_{EAOS} + .2^{*}CR_{non-EAOS}$.

The model allows the user to determine the fraction of pilots reaching EAOS at each year of service, and that fraction then changes as the active duty service obligation changes. For example, if when the ADSO is 5 years, 80 percent of pilots reach EAOS at YOS 7, then when the ADSO is increased to 6 years, 80 percent of pilots probably reach their EAOS at YOS 8. Since flight school is longer for pilots than for NFOs, the timing to EAOS may differ for the two groups. The model accounts for this difference by providing separate timing inputs for the two groups.

RECRUITING AND THE ADSO

In considering changes in the active duty service obligation, the chief negative concern is its effect on recruiting. An increase in the active duty service obligation is likely to reduce the attractiveness of aviation to some potential recruits.[1] Naval aviators are recruited from three sources: the United States Naval Academy (USNA), Naval Reserve Officer Training Corps (NROTC), and Officer Candidate School (OCS). For both the USNA and NROTC, quotas are set each year that determine the number of officers from these sources that will be permitted aviation. These quotas have been relatively stable over time. Recruiting from OCS depends on total requirements and the number filled from the other sources. OCS recruitment has varied much more widely over time. Regardless of the source, potential officers have alternatives to choosing aviation, and the increase in the ADSO

1. For other recruits, perhaps even most, it might have no effect.

may turn some potential recruits to other pursuits. For USNA officers, the alternatives include other Navy communities, such as submarines or surface warfare and Marine Corps aviation. For example, the active duty service obligation in Marine Corps aviation is currently 4-1/2 years. If the difference in ADSO grows, a larger percentage of potential aviators could be siphoned off by the Marine Corps. Even if the USNA quota is filled, it is quite possible that the quality of students entering aviation will fall. Similar arguments could be made about NROTC. In the most difficult recruiting arena, OCS, the main alternative is the Air Force. The Air Force recently increased its active duty service obligation to eight years. Given the difficulties associated with Navy deployments, many Navy policymakers feel that the Navy's ADSO should be less than the Air Force's.

The effect on recruiting and the quality is clearly one factor that needs to be considered in deciding on the active duty service obligation. The model assumes that the student graduation rate declines at an increasing rate as the active duty service obligation increases. The specific functional form for this relationship is assumed to be the following:

$$Graduation\ Rate \ = \ A - B(ADSO - 5)^2 \ ,$$

where A is the graduation rate when the active duty service obligation is 5, and B is the coefficient that determines the rate of decline. As B increases. the graduation rate decreases at an increasing rate. The model user sets the value for the two parameters in this function. If the argument about a decrease in graduation rates as the ADSO increases is not accepted, the parameter B can be set at zero.

PAY, ALLOWANCES, AND BONUSES

One of the outputs of this model is the total cost of officers in the aviation community through the first 15 years of service. One of the major components of this cost is the level of pay, allowances, and bonuses. Pay and allowances are entered for each year of service. They include base pay, the basic allowance for subsistence (BAS), and the basic allowance for quarters (BAQ). If it is possible to determine the average level of Variable Housing

Allowance (VHA) at each year of service, this allowance could also be included. Since base pay and some allowances depend on rank, it is necessary to assume a promotion path. A reasonable assumption for the promotion paths is to follow that designated in the *Career Planning Guidebook* (see figure 1). According to this schedule, promotion to lieutenant junior grade occurs after the completion of 2 years of service; promotion to lieutenant occurs after 4 years; promotion to lieutenant commander occurs after 9 years; and promotion to commander occurs after 15 years.

The pay information also includes, as separate inputs, the Aviation Career Incentive Pay (ACIP) and the Aviation Officer Continuation Pay (AOCP). ACIP depends on years of service and whether or not the officer is receiving AOCP. Beyond five years of service, ACIP is $400 per month for those not receiving AOCP, and $306 per month for those receiving AOCP. AOCP depends on the number of additional years of obligated service the officer undertakes, and the amount of the bonus per year of obligation. The model requires the user to enter the level of AOCP for obligation lengths of three, four, and six years. In addition, the user is required to enter the fraction of aviators that sign up for each bonus level.

ANALYSIS OF ADSO FOR PILOTS

The ADSO model can be used to analyze the lowest-cost service requirements for pilots and NFOs. Many of the inputs for the model need to be supplied by the Navy (OP-59). Because of time limitations on this project, the detailed analysis is limited to pilots.

Naval aviation is composed of three major components or communities, based on type of aircraft. The three communities are jets, helicopters (helo), and propeller (prop).[1] Because of differences in some key inputs across communities, the model has been configured to treat the three communities separately. The results of three communities can then be combined to provide an aggregate picture of all of naval aviation.

DIFFERENCES IN INPUTS ACROSS COMMUNITIES

The three communities differ in three key areas: cost of training, billet structure, and continuation. These differences are the result of differences in the length and nature of the training, the number and configuration of squadrons, and opportunities for pilots both inside and outside the Navy.

Table 2 shows the Navy's estimates of the cost of training pilots and the billet structure for each community. The billet structure is characterized by the first sea tour, the shore tour (instructor), and the department-head tour, which are the three tours explicitly dealt with in the model.

The cost of training a jet pilot is more than twice that of other types of pilot because the training "pipeline" is longer and the equipment is more expensive to procure, run, and maintain. Jet pilots spend nearly two years in basic and advanced flight training before designation, whereas prop and helo pilots spend only about a year and a half. Given the high cost of jet training, the cost-minimizing service requirement for jet pilots is more likely to be influenced by the need to keep a relatively low pilot-training rate relative to the other communities.

1. The prop community is also referred to as maritime.

Table 2

Cost of Training and Billet Structure,
by Pilot Community

		Billets		
Community	Cost	First Sea	First Shore	Department-head
Jet	$1,100.	1,010	1,060	324
Prop	440.	1,069	870	273
Helo	340.	884	680	395

NOTE: Cost of training in thousands is cost per pilot.

A useful starting point for understanding the billet structures is to compare the calculated ratio of first-shore-tour billets to first-sea-tour billets and of department-head billets to first-sea-tour billets. In the jet community, this ratio of first-shore-tour to first-sea-tour billets is about 1.05; in the other communities it is about 0.8. The ratio of department-head billets to first-sea-tour billets is about 0.45 in the helo community and about 0.3 in the other two communities.

The relative size of these ratios focuses on the crucial tour in each community. The jet community has the most instructor-intensive billet structure, which indicates that the instructor shortage (in the first shore tour) is most likely to be acute in this community. In fact, under the current career path (i.e., tour length) the shortage of the instructors would persist regardless of the ADSO. Under the current career path, the first sea tour is approximately three years, and the first shore tour is approximately 2-1/2 years. Now suppose the ADSO can be increased to eliminate all attrition during the first shore tour without any other negative consequences. In this case the annual requirement in the first shore tour is 424 (1,060/2.5). Given the first-sea-tour billets total 1,010, and also assuming no attrition, the annual output of pilots from the first sea tour is about 337 (1,010/3). At best, increasing the ADSO reduces the first-shore-tour shortage to 87 (424-337) per year. In addition to increasing the ADSO, at least two other policy options can be used in addressing the shortage: increasing the pilot training rate or changing the tour lengths. Increasing the training rate for jet pilots is a relatively unattractive alternative, given the high cost of training. Changing tour lengths, particularly lengthening the first shore tour, seems to be a relatively cheap method of dealing with the shortage. Returning to the example, increasing the first shore tour to 38 months reduces the annual requirement to 335 and eliminates the shortage. Note that this solution is for illustrative purposes only, because it does not account for attrition that is unrelated to the end of the service obligation. The discussion of the model to follow examines these types of tradeoffs in more detail.

In the helo community, first-sea-tour output is 295 (884/3) and first-shore-tour requirement is 272 (680/2.5). In the prop community, the output is 356 (1,069/3) and the required input is 348 (870/2.5). Of course, these examples do not account for attrition, which is captured in the model. Unlike in the jet community, in these communities, where the annual output from the first sea tour exceeds the annual requirement for the first shore tour under conditions of no attrition, the annual flow between the first sea and first shore tours is not the problem.

The structures of these communities are weighted more heavily toward the other key billets. The helo community has relatively higher department-head requirements, and the prop community has relatively higher requirements for first sea tour. Given these differences, the ADSO could have a different impact on each of the communities.

The other factor that differs across communities is in the area of continuation. The outside employment opportunities differ across the three communities, and these are reflected by differences in the continuation history and the responsiveness to changes in pay and bonuses across the three communities. Table 3 shows the cumulative continuation rates and measures of responsiveness of the continuation rate to changes in the level of compensation. The rate used to measure continuation is the cumulative continuation rate for 6 to 11 years of service (CCR_{6-11}); it is supposed to measure the probability that a pilot in the 6th year of service continues until the 11th year of service.[1] The effect of compensation on continuation is measured in two ways. In table 3, the column headed with the term "Slope" shows the effect of a $1,000 increase in the present value of compensation on the continuation rate. For example, if the bonus paid to jet pilots increased by $5,000, the continuation rate would be expected to increase by .0115 (.0023*5) or 1.15 percentage points. If no other factors changed, the continuation rate would increase from 36 percent to 37.15 percent. An alternative method for characterizing the effect of compensation on continuation is the elasticity. The elasticity is defined as the percentage change in the continuation rate divided by the percentage change in compensation. For example, if jet compensation increased by 10 percent, the continuation rate would increase by 2.66 percent. The ADSO model uses the slope in calculating the continuation rate. The appendix to this research memorandum describes in detail the theoretical underpinnings and statistical methodology used to determine the continuation parameters in table 3.

Table 3

Continuation Factors of Pilots, by Community

Community	CCR_{6-11}	Slope	Elasticity
Jet	.36	.0023	.266
Prop	.19	.0023	.269
Helo	.55	.0033	.384

Helo pilots have the highest continuation rates and are also most sensitive to changes in compensation. Jet and prop pilots, both of whom have greater opportunities to work as pilots in the civilian economy, are about

1. The CCR_{6-11} is the Navy's official measure of continuation. As such, it was used as the base case. However, the CCR_{6-11} methodology has a number of problems. Most important is that it overestimates the net change in the size of a community because it does not account for gains to a community through lateral transfers from either inside or outside the Navy (e.g., from the Marine Corps) or returns to active duty. When the CCR is applied to a starting inventory, it is likely to underestimate the actual final inventory. Furthermore, the CCR methodology does not consider changes in year group size. A more detailed critique of the CCR methodology is contained in [3] and [4]. The exploratory analysis examines the effect of raising the base continuation rate on the results.

equally sensitive to changes in compensation. These figures indicate that it is more expensive to increase the continuation rate of jet and prop pilots than of helo pilots because each $1,000 of added compensation has a smaller effect on the continuation rate. For a helo pilot, an increase in compensation by $5,000 raises the continuation rate by 1.65 percentage points as compared to 1.15 percentage points in the other communities. The relative levels of the continuation rates are reflected in these differences across communities. Over the past four years, jet and helo pilots have generally been eligible for a bonus, but prop pilots have not. The bonuses are nearly equal for all pilots eligible.[1] The bonus has a larger effect on helo pilots than jet pilots, so that the resulting continuation rate in the helo community is higher than that in the jet community. The prop community, which has not been eligible, has the lowest continuation rate of the three.

ADSO SIMULATIONS

The purpose of the ADSO model is to analyze the relative cost of different ADSOs. The model is run using the inputs described above for each of the three aviation communities. The results of each community are then aggregated to create a picture of the entire aviation community. In this section the results of the simulations are presented graphically.

Figure 2 shows the relative cost of the four different ADSOs for each of the three communities. The minimum-cost ADSO is different in each of the three cases. In the jet community, the minimum cost is achieved at seven years, in the prop community, at six years, and in the helo community, five years. These differences are the results of the different inputs described previously.

The shortage of pilots in the first shore tour is most acute in the jet community. Consequently, under most circumstances the first shore tour is the binding constraint. In this situation, retaining pilots until they have

1. Some jet pilots are eligible for the bonus in a lump sum, which has a somewhat higher present value.

completed their shore tour has a cost advantage because lower attrition permits a reduction in the training rate[1] and inventory of first sea tour. Since increasing the inventory is costly, particularly for jet pilots, increasing the ADSO reduces the overall community costs. The total cost increases after seven years for two reasons: the model assumes a cost associated with increases in the ADSO in the form of higher attrition from flight school;[2] and retaining a large pre-ADSO inventory beyond the first shore tour is costly.

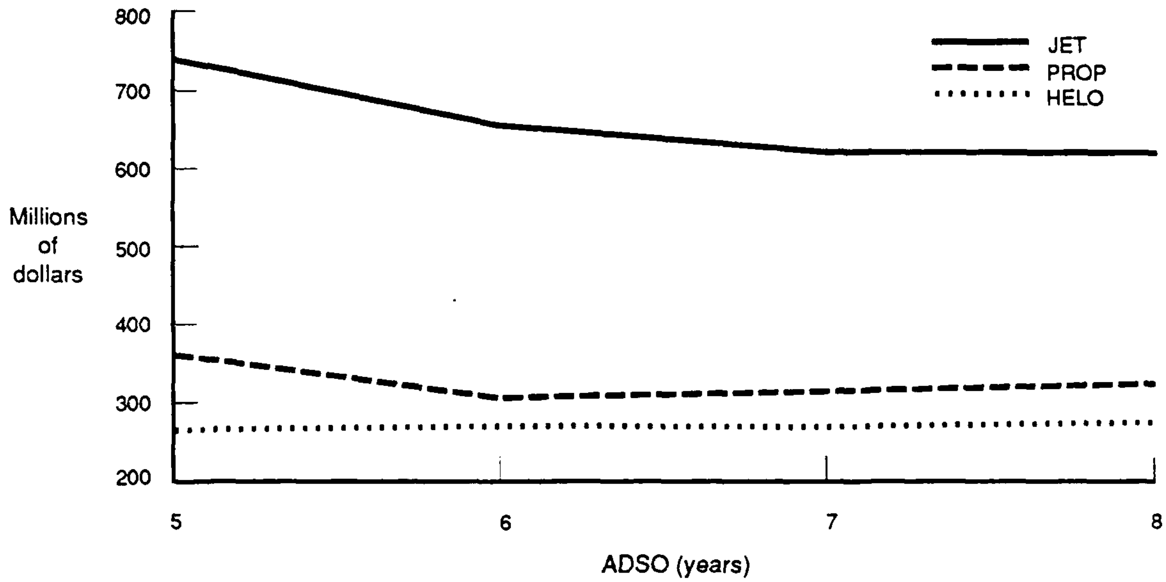

Figure 2. Total annual cost of pilots to YOS 15, by ADSO and community

On the opposite extreme from the jet community is the helo community,

1. Currently, the Navy determines the pilot training rate by requirements for first sea tour and not for first shore tour. In this sense the model is not realistic. However, to the extent that the Navy plans to meet its instructor requirements with sea-experienced junior aviators, the model simply illustrates that a shortfall will persist as long as the first shore tour is the binding constraint.

2. Simulations with alternative specifications of the flight-school attrition rate were conducted. This analysis revealed that only when the parameter is such that the penalty for increasing the ADSO is unrealistically harsh, for example, implying a 50-percent flight-school attrition rate, is the solution affected.

for which cost-minimizing ADSO is at five years. In the case of the helo community, the model is illustrating that a change in the ADSO is not a solution to helo-community concerns. Given the billet structure, the binding constraint is the department-head tour. Increasing the ADSO to any reasonable level does not address potential shortages of department heads because under the current career path[1] the department-head tour is completed at YOS 14 or 15, which is well beyond the first decision point. The small rise in the total cost as the ADSO increases reflects the cost of the higher inventories at more senior paygrades and the penalty of flight-school attrition.

The intermediate case is in the prop community where an increase in the ADSO from five to six years causes a reduction in the total cost. Further increases in the ADSO lead to slightly higher total costs. The current requirements configuration in the prop community is such that a change in the ADSO from five to six years causes a shift in the the binding constraint from the first shore tour to the department-head tour. This shift reduces the training requirements and thereby leads to cost savings. Further increases in the ADSO have the same effect in the prop community as they do in the helo community.

Figure 3 shows the overall cost of pilots as the ADSO increases from five to eight years. The overall results are dominated by the results in the jet community. The jet community is the most expensive to train and retain, and the effect of changing the ADSO has the greatest impact on the total cost. The effect of the ADSO changes is relatively small in both the prop and helo communities.

1. Because of the requirement for joint service in the O-4 to O-6 ranks, the department-head tour may be earlier in the career. In this case, the model will need modification and the ADSO issue will need further analysis.

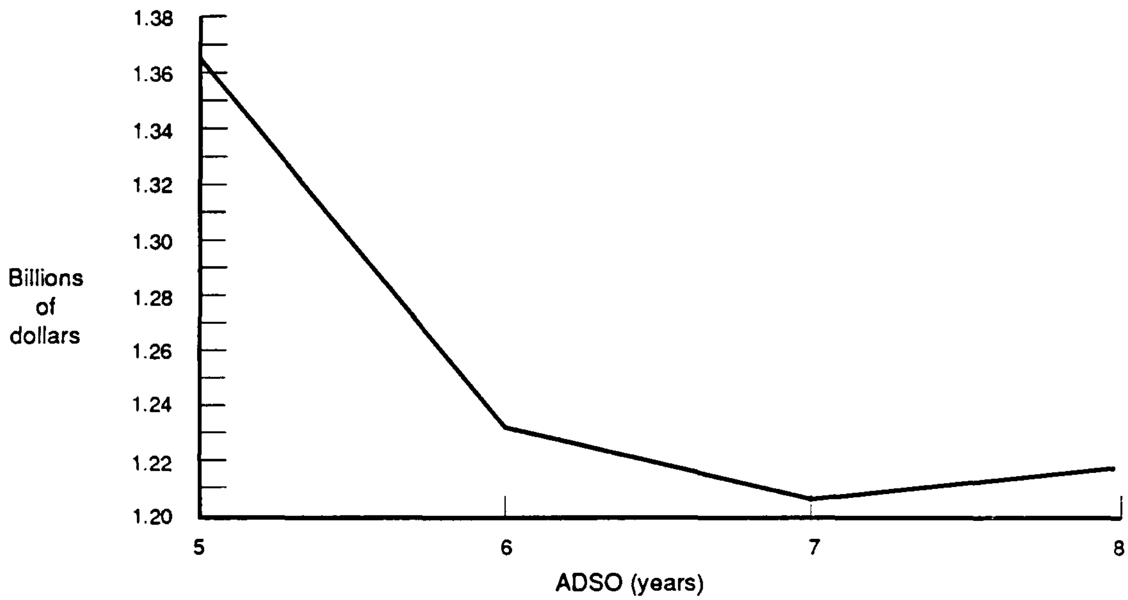

Figure 3. Total annual cost of pilots to YOS 15, by ADSO

EXPLORATORY ANALYSIS

The purpose of this section is to explore possible uses of the simulation model. The analysis in the previous section determined the minimum-cost ADSO in each community based on values for the inputs suggested by the Navy. In this section, the values of some of the variables are allowed to vary widely in order to see what effect such changes have on the minimum-cost ADSO.

The analysis focuses on two key variables in the model: the billet structure and continuation behavior. By allowing these variables to change, the analysis demonstrates how robust the model is, that is, whether small changes in these key variables cause a change in the minimum-cost ADSO. The setting of the ADSO establishes a continuing policy for the Navy, which is likely to be maintained for a long time. Over time some of the key variables are likely to change, and it would be useful to know whether small changes in these variables would have an impact on the minimum-cost ADSO. For example, continuation behavior depends on factors outside the control of the Navy, such as civilian airline hires and other civilian economic conditions. As underlying conditions change, the continuation behavior is also likely to change. The question is: What type of changes would lead to a change in the minimum-cost ADSO?

For the purposes of this analysis the entire billet structure is collapsed into a single statistic, b, which is the ratio of annual department-head requirement and annual first-shore-tour requirement. Annual requirements are determined by dividing the total billets (tb) by a selectivity factor (s) multiplied by the average tour length (tl). More formally, the subscripts in the equation are for department head (dh) and first shore (fsh):

$$b \;=\; \left(\frac{tb_{dh}}{tl_{dh} * s_{dh}}\right) / \left(\frac{tb_{fsh}}{tl_{fsh} * s_{fsh}}\right) \; .$$

For example, in the base case in the jet community, the number of first-shore-tour billets is 1,060, the number of department-head billets is 324, average tour lengths are 2-1/2 years, the selectivity factor for the first-shore tour is 1 and for the department-head structure is 0.34. Increases in the value of b indicate a billet structure that is weighted more heavily toward department-head billets. Changes in b could result from changes in any of the variables in the equation. A 10-percent increase in the number of department-head billets has the same effect on the billet structure as a 10-percent decrease in the number of instructor billets. One assumption that is made in this analysis is that the first-sea-tour billets never become the binding constraint. In other words, changes in either the department-head billets or the instructor billets imply an unspecified change in the number of first-sea-tour billets. Without this assumption, the following analysis would not be possible.

Figure 4 illustrates the exploratory analysis for the jet community. On the horizontal axis are continuation rates from YOS 6 through YOS 11. The inputs of the model can be manipulated to generate these different continuation rates. For each continuation rate, the billet structure inputs can also be varied so that the variable b takes on different values. For a given value of the continuation rate and the billet structure, the ADSO model determines the cost-minimizing ADSO. Small changes in the inputs generally do not change the cost-minimizing ADSO. The lines divide the figure into regions, and the numbers in each region indicate the cost-minimizing ADSO for all the combinations of continuation rates and billet structure in that region. In some cases the cost of two different ADSOs does not differ. For example, one of the regions in figure 4 is labeled 5/6. The shaded circles along the borders indicate regions in which small changes in one of the variables changes the cost-minimizing ADSO.

In the jet community the base-case value for the variable b is 0.34. Continuation rates among jet pilots for recent year groups are typically between the mid-forties and mid-fifties.[1] The current situation in the jet community, indicated by point A in figure 4, is mired deep in the region with a cost-minimizing ADSO of seven years. A conclusion that can be drawn from this figure is that it is unlikely that the inputs would change radically enough in the near future to shift the cost-minimizing ADSO.

1. These rates refer to net continuation rates. See [3] for details.

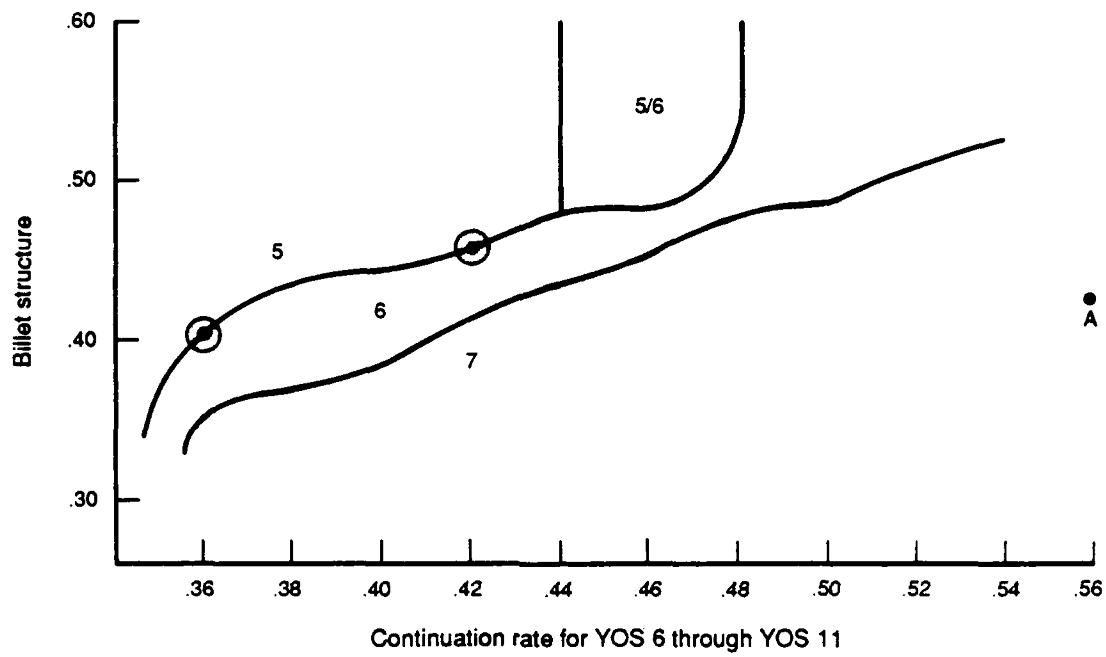

Figure 4. Minimum ADSO, by continuation rate and billet structure, for jet pilots

Figures 5 and 6 use the same methodology as figure 4 to portray the situations in the prop and helo communities. The figure for the prop communities covers a lower range of continuation rates, as current data suggest low continuation in that community. Figure 6, for the helo community, examines higher values for the billet structure parameter, b, because the helo community's billet structure is heavily oriented toward department-head billets. Of the three communities, the prop community is only one in which a small change in either the continuation rate or the billet structure produces a change in the cost-minimizing ADSO.

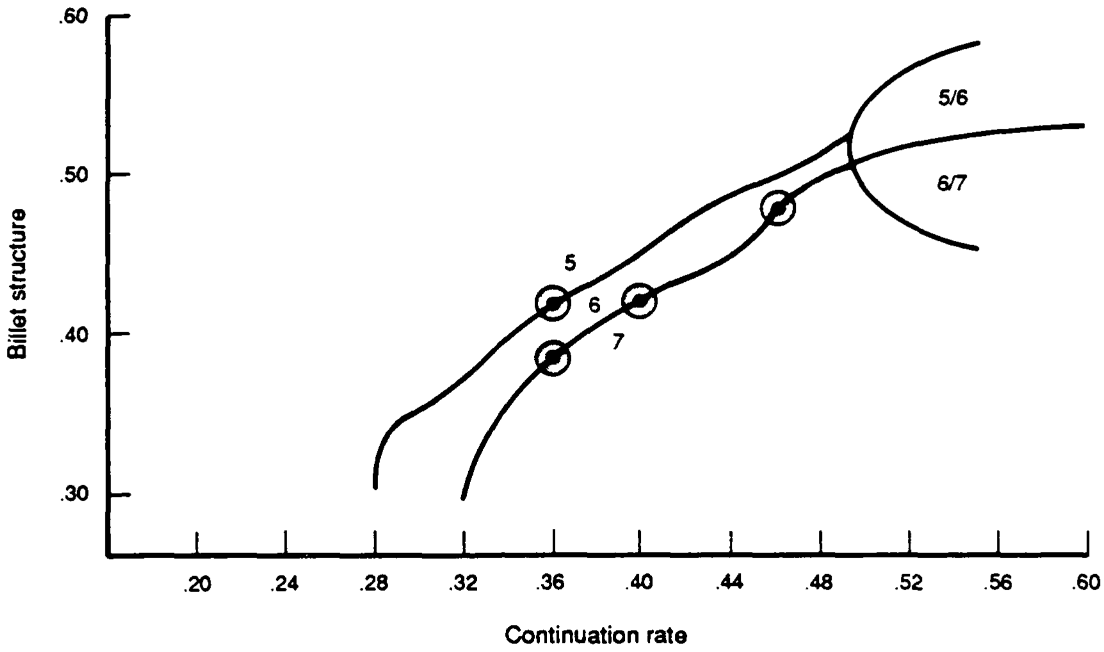

Figure 5. Minimum ADSO, by continuation rate and billet structure, for prop pilots

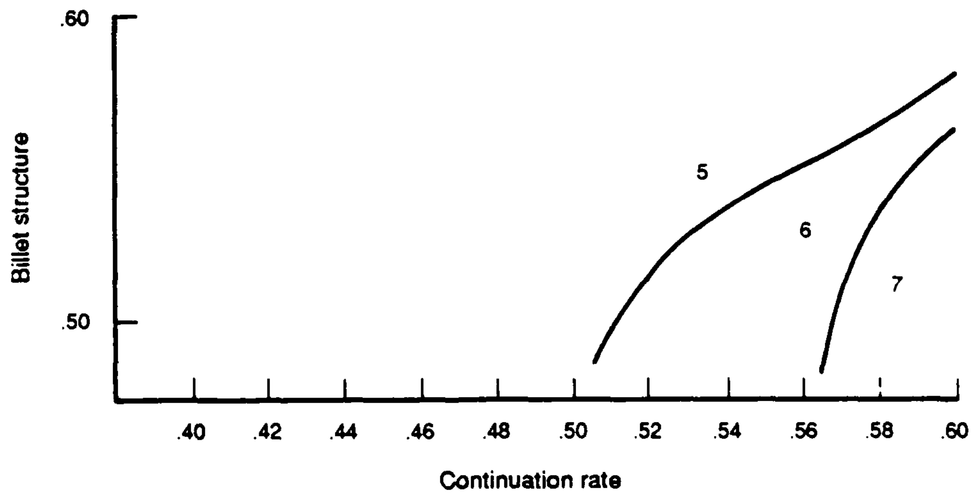

Figure 6. Minimum ADSO, by continuation rate and billet structure, for helo pilots

CONCLUSIONS

This paper has described the aviation community ADSO model, which was devised to assist policymakers in determining the cost-minimizing ADSO for aviators. The model provides useful inputs in reaching such a decision, but it does not by itself determine the optimal ADSO.

The model is based on the assumption that the aviation community should be shaped by the requirement to fill the first shore tour (instructor tour) and the third sea tour (department-head tour). In the model only one of these constraints can be binding at any one time. The binding constraint is used to determine the number of pilots and NFOs to recruit.

The paper also illustrates how the model can be used to investigate the question. Starting with a base case, a number of analyses on the sensitivity of the outcome to the variables are considered. The results of the sensitivity analyses can be summarized as follows:

- In most cases the least-cost value for the ADSO is seven years. Changing the input values, even by relatively large amounts, generally did not change this result. Given the values in the base case, the requirement to fill first-shore-tour billets dominates. With an ADSO of seven years, most aviators complete the first shore tour before reaching their reenlistment-decision point. This point helps minimize the training rate, which is a major driver of the model.

- The model is much more sensitive to changes if small changes in variables cause a change in the binding constraint. The most likely way to alter the binding constraint is to change the billet structure. If the billet structure included relatively more department-head billets, the model would be more sensitive to input changes.

This model is a relatively simple representation of the aviation community. Further work is required in a number of areas, including identifying other possible constraints, the effect of pay and other factors on retention, the cost of training, and the effect of changing the active duty service obligation on recruit quality.

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[2] Department of the Navy, *U. S. Navy Unrestricted Line Officer Career Planning Guidebook*, 1986

[3] Center for Naval Analyses Research Memorandum 88-113, *A Critical Evaluation of the Cumulative Continuation Rate Methodology*, by Donald J. Cymrot, Jul 1988 (27880113)[1]

[4] Center for Naval Analyses Research Memorandum 88-90, *Determining Continuation Rates for Pilots from the Officer Master File*, by Donald J. Cymrot, Patricia E. Byrnes, and Joseph T. Schertler, Jun 1988 (27880090)

1. The numbers in parentheses are CNA internal control numbers.

APPENDIX

THE EFFECT OF COMPENSATION ON THE RETENTION OF PILOTS

APPENDIX

THE EFFECT OF COMPENSATION ON THE RETENTION OF PILOTS

The empirical approach most commonly used in retention studies in the armed services is known as the Annualized Cost of Leaving (ACOL) approach. The ACOL approach was first used as a method for examining retirement issues, but it has been subsequently used in numerous analyses of retention issues including aviation bonuses. [1]

The basic idea in the ACOL approach is that the individual decides whether to remain in the armed services based on the perceived costs and benefits of the alternatives. The theoretical model assumes that an aviator's goal is to *maximize utility*; that is, given a set of alternatives, the individual chooses the one that produces the greatest satisfaction.

Utility (or satisfaction) has both a monetary and a psychic, or taste, component. The model derives its name from the monetary component, which is called the annualized cost of leaving, or ACOL. The ACOL component is defined as the difference between the expected present value of total compensation from continued military service and the expected present value of total compensation from civilian employment. No distinction is made among the various sources of military compensation. A dollar of basic pay has the same effect as a dollar of ACIP or a dollar of an AOCP bonus. The only adjustment made to the value of various sources of pay is for the timing of the receipt, so that a dollar of current pay has a larger impact than a dollar of retired pay to be received in 10 or 15 years. Also, no distinction is made among the various sources of civilian pay; a dollar

1. The ACOL approach should not be confused with the ACOL model . The ACOL model is a simulation model that projects force endstrengths at different paygrades and years of service over a seven-year planning horizon. This model was originally developed at CNA for the Navy, and then reestimated and expanded to cover all the services as part of the Fifth Quadrennial Review of Military Compensation. The simulation model is based on the ACOL approach, but relies on stronger assumptions than are made in the theoretical model.

of cash wages has the same impact as a dollar's worth of fringe benefits. ACOL is specified as

$$ACOL = M + B - C \ , \tag{A-1}$$

where M is the present discounted expected value of military pay excluding bonuses, B is the present discounted expected value of the bonus, and C is the present discounted expected value of civilian pay. In specifying ACOL for studying the effect of bonuses on retention, bonus dollars are often entered as a separate term to highlight the role of the bonus in the retention decision. This specification, however, does not imply anything special about the bonus; a one-dollar increase in the present value of a bonus increases ACOL by the same amount as a one-dollar increase in the present value of B or a decrease in C.

Although the model takes its name from the monetary component of the utility function, taste for military service may play an equally important role in the continuation decision. Some personnel derive positive benefits just by being in the military. Perhaps it is the job security, the challenge (e.g., landing on an aircraft carrier), the structure, the travel, patriotism, or a combination of all these factors that makes military service more attractive than civilian employment. Others view military service in negative terms: regimentation, danger, lack of individual choice. For those people, civilian employment is more attractive. The psychic component is represented by the parameter δ. The parameter δ is the amount that an individual would be willing to pay (or, if negative, require to be paid) to remain in the military. For example, if δ is \$1,000, he would be willing to remain in the Navy even if his total military compensation, including pay and bonuses, is \$1,000 less than his civilian opportunities; that is, even if ACOL = -\$1,000.

The individual evaluates the relative monetary benefits and weights them against the psychic benefits in deciding whether to continue in military service. The individual's decision whether to stay or leave can be summarized as follows:

$$\begin{aligned} If\ ACOL + \delta &> 0,\ then\ stay, \\ If\ ACOL + \delta &< 0,\ then\ leave. \end{aligned}$$

If the sum of the two factors equals zero, the individual is indifferent about staying and leaving.

The tradeoff between monetary and psychic benefits is often ignored and leads to much misunderstanding about the model. The model does not imply that if military pay is higher than civilian pay, the individual necessarily stays, and if civilian pay is higher, the individual necessarily leaves. Some personnel remain in the armed services even though they could make more money in civilian life because they prefer military service. Conversely, others choose to leave the military even if military pay is higher than civilian pay, because they prefer being civilians. In this analysis, it would, in fact, be consistent with the model to find that some personnel with positive monetary benefit from continued service leave, while others with negative monetary benefit from continued service are remaining, if those who continue exhibit stronger preferences for military service than those who leave.

EMPIRICAL IMPLEMENTATION

The empirical version of ACOL is an adaptation rather than a direct application of the theory. The theory is deterministic; using an individual taste parameter, it shows the minimum monetary conditions required to induce each individual to stay in the Navy. The problems in empirically implementing the deterministic version of this model are severe, because it requires assigning a value of δ for each pilot reaching ADSO. This requirement could be met either by asking each individual how much he would be willing to pay (in the form of lower compensation than available in the civilian economy) or would require to be paid (in the form of higher compensation) to remain in the Navy or by using estimates of δ for a few individuals to generalize to all pilots reaching ADSO. Each of these strategies has problems. The problem with asking individuals about their values for δ is that the answers would not necessarily be reliable, and even if the answers were reliable, such a procedure would make it difficult and expensive to forecast retention rates, because for each forecast there would have to be a new survey of those pilots reaching ADSO during the forecast period. The problem with generalizing from a sample of a few pilots is that according to modern utility theory it is not possible to make interpersonal comparisons of tastes. The parameter δ represents the individual's taste for military service. If the tastes of one individual cannot be compared with that of another, it is not possible to generalize the value of δ for a population solely from a sample of that population.

As a consequence of the problems in using the deterministic version of the model, the ACOL model is empirically implemented in a probabilistic form. A deterministic model would predict whether each individual stays or leaves the Navy; a probabilistic model estimates the probability that each individual stays or leaves. The major difference between the two is the treatment of the δ. In a deterministic model a δ is assigned to each individual. Individuals are then categorized as stayers or leavers based upon sum of ACOL and δ. The retention rate among a group of pilots reaching ADSO is the percentage of the total that are categorized as stayers. In a probabilistic model the preferences of each individual are not known, only the overall distribution of preferences. An individual pilot could fall anywhere in that distribution of tastes; so the outcome of his decision is not known with certainty. The predicted retention rate for the population is the average of the estimated individual probabilities.

THE MODEL

In the ACOL model the underlying distribution of preferences for military service has generally been assumed to fit a logistic distribution. This assumption of a logistic distribution is made because it provides a reasonable fit of the data and is relatively easy to use. The logistic distribution is symmetrical and has a declining density in its tails. This shape implies that changes in the cost of leaving have a larger impact on the retention rate when the retention rate is in the middle range, that is, between 0.2

and 0.8, than when it is at either extreme. This implication is thought to have intuitive appeal because it suggests that the number of people with extreme tastes, either strongly for or strongly against military service, is relatively small. If tastes are distributed logistically, the model can be estimated using the maximum likelihood technique known as logit.[1]

The logit equation has the following form:

$$P(c=1) \;=\; \frac{1}{1+e^{\alpha+\beta ACOL}} \;, \qquad \text{(A-2)}$$

where P is a probability operator, and c equals 1 for continuing in the Navy and equals 0 for leaving. $ACOL$ is the difference between the value of military and civilian compensation. In practice, $ACOL$ is often broken into several components with its own β. The parameters of the taste distribution are captured in the intercept, α. The predicted probability of continuing, $\hat{p}_c$, for a given level of ACOL is determined by substituting the estimated values of α and β into the equation. The predicted probability of leaving, $\hat{p}_l$, equals (1 - $\hat{p}_c$).

In most cases the logit coefficients, by themselves, cannot be used in manpower models because they do not reveal the magnitude of the effect that the pay change has on continuation. The coefficients, which are the slopes of the likelihood function with respect to each variable, must first be transformed into the slope of the logit function, or an elasticity. These alternative transformations for logit coefficients can be used to characterize the sensitivity of continuation rates to changes in pay or any of the other independent variables in the model.

The slope of the logit function in the retention equation is the change in the probability of the continuation divided by the change in the bonus. Since pay is a continuous variable, the slope can be determined by using

1. An alternative procedure is to assume the distribution is normal and estimate the model as a probit. Logits are more convenient to work with because the normal distribution is not a closed form. In practice there is little difference between logit and probit estimates. The basic results of the analysis would not be affected by substituting a probit for the logit estimations.

the derivative of the logit function with respect to a change in the bonus, that is

$$\frac{\delta L}{\delta ACOL} = \beta p_c(1 - p_c) \ . \tag{A-3}$$

An alternative method for measuring effects of changes in data is the elasticity. In general, elasticity is defined as the ratio of the percentage change in the dependent variable divided by the percentage change in the independent variable. An elasticity is a unitless measure of the sensitivity of one variable to another. One general advantage of elasticities over slopes is that elasticities account for the relative size of the change in a variable. A 5-percentage-point change in the retention rate is a larger relative change if the retention rate is 10 percent than if it is 90 percent. A 5-percentage-point change at 10 percent is a 50-percent increase, but a 5-percentage-point change at 90 percent is only about a 6-percent change. The slopes of the logit may be the same at 10 and 90, but the elasticity is larger at 10 percent. Elasticities are also useful for comparing the effects of different types of variables, such as bonuses, which are measured in thousands of dollars, and unemployment rates, which are measured in percentage points.

In this context the elasticity of continuation with respect to the bonus is defined as

$$\eta_{ACOL} = \frac{\Delta p_c}{\Delta ACOL}\frac{\overline{ACOL}}{\overline{p_c}} \ . \tag{A-4}$$

This expression can be transformed by substituting the slope formula for $(\frac{\Delta p}{\Delta ACOL})$, which gives

$$\eta_{ACOL} = (1 - p_c)\beta\overline{ACOL} \ . \tag{A-5}$$

In this form, the elasticity is shown to be proportional to both the value of $\overline{ACOL}$ and (1 - p_c). This characteristic is important for two reasons. First, it explains why measures of continuation elasticities in different studies can produce widely different results. If $ACOL$ is measured differently across studies, then the elasticities are likely to be different also. Second, the elasticity is sensitive to the probability of continuation, in fact, more sensitive than is the slope of the logit function. The slope of the logit function depends on p_c (1 - p_c), which is more stable than (1 - p_c) by itself.

Given the relative stability of the slope of the logit function as compared to the elasticity, it is generally better using the slope for policy analysis. In the simulation model used in this study, the probability function is built in. The slope of the probability function is used to predict the effects of the changes.

Specification of ACOL

According to the theory, the ACOL variable is a single variable that captures all financial aspects of the individual's choice between continuing in the Navy and leaving. However, there are a number of problems in measuring ACOL because of the difficulty in obtaining data about alternatives to military service and the large amount of uncertainty about the future levels of both military and civilian pay. In practice, ACOL is generally entered as a series of variables, which are intended to capture different aspects of the decision.

In this case the statistical model is designed to fit into the simulation model on the effect of changing the ADSO. Because of this intended use of the estimates, a specification was chosen with a relatively small number of variables. The basic specification focuses on two issues: relative pay and the demand for civilian employment. Relative pay is the classic ACOL variable and in this case is measured as the difference in the present value (using a 10-percent discount rate) between project military and project civilian pay.[1] The relative pay includes basic pay, ACIP and AOCP bonuses (when availabl), and a measure of civilian pilot pay. The measures of civilian employment demand are the number of civilian airline hires (lagged by one year) and the civilian unemployment rate for males age 20 and over. Increases in relative military compensation and the civilian unemployment

1. The classic specification of ACOL divides this difference by a constant discounting factor. This discounting factor converts the total difference to an annualized difference. This practice was not followed here because it seemed easier for the simulation model.

rate are expected to increase the continuation rate, and increases in civilian hires are expected to decrease the continuation rate.

Data

Previous studies of the relationship between pay and continuation of pilots in the Navy and Marine Corps have relied on grouped data because tracking individuals has not been possible. An important improvement of this analysis over previous ones is that individuals are tracked. The tracking of individuals vastly increases the number of observations and should improve the fit.[1]

The data for this analysis cover the period from FY 1982 through FY 1987. A new AOCP program was started in 1981, but it was not feasible to include information from the first year in the analysis. Individuals are tracked using the Officer Master Files (OMFs) starting with 1981. Records are matched across consecutive years using Social Security numbers. When no record match is found in the second year, the person is designated as having left. For example, in examining the decision to remain while the 1982 program was in effect, all active-duty pilots from the FY 1981 tape are matched to the FY 1982 tape. Since these tapes are dated from the last day of the fiscal year, a comparison of the 1981 and 1982 data follows pilots during the entire fiscal year of 1982.

The matched data set includes pilots that are both eligible and ineligible for a bonus and eligible and ineligible to leave. Eligibility for a bonus was determined by the pilot's primary Additional Qualification Designator (AQDs). A list of eligible AQDs was obtained from OP-59. Identifying who was eligible to leave was a difficult problem. Anyone with a minimum service requirement date after the last day of the fiscal year was considered ineligible and eliminated from the data set. In addition, anyone who had previously received a bonus and had a continuing obligation from that bonus was also considered ineligible to leave. A list of bonus recipients from

1. The increased number of observations does not necessarily increase the cross-sectional variation in some of the variables, which would further improve the fit.

between 1982 and 1987 was obtained from NMPC-43.[1] Previous bonus recipients, who were ineligible to leave, were also eliminated from the data set. Also, anyone with more than 11 years of service was eliminated because these pilots are ineligible for a new AOCP bonus.[2]

The military pay variables, except for the AOCP, are derived from the pay tables. Both military and civilian pay are calculated to the point at which the pilot would reach 20 years of service. For example, for someone at YOS 6, the pay variables are projected out for 14 years, but for someone at YOS 7, the variables are projected out for only 13 years. Annual pay was determined assuming on-time promotion to each paygrade. The military pay variable measures potential military pay and not actual military pay. Potential and actual military are equal in all cases except that of the AOCP. A pilot who could take a bonus but does not has a higher potential pay than actual pay. If actual pay was used instead of potential pay, everyone who leaves would have a lower actual pay than potential pay and the effect of pay on the continuation decision would be biased downward.

Pay of civilian pilots is used as the proxy for civilian pay. The profile of civilian earnings from 1986 was taken from a paper by Henderson and Kriegal.[3] The profile of pilot pay by years of experience was assumed to be fixed over the 1982 to 1987 period, but the current value of that profile was assumed to change by the percentage change in the pay of civilian pilots as reported by the Bureau of Labor Statistics.

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1. Information on 1981 bonus recipients was also obtained, but it was not feasible to include this information in the current estimates.

2. Another category for elimination are those who have attended the NPGS within the last three years because their attendance brings with it an additional service obligation. It is however, difficult to determine whether the decision to stay was made before or after the decision to attend NPGS. Further analysis of this issue is warranted.

3. *Pay Comparability: A Case Study of U. S. Navy Versus Civilian Pilots*, Naval Postgraduate School, October, 1986. This paper was derived from LCDR Kriegal's Master's Thesis.

Continuation Estimates

For the purposes of estimation, the model (equation A-2) is transformed into a linear formula by dividing both sides by (1 - p_c) and taking the natural logarithm of both sides. The estimation equation is

$$ln\frac{p_c}{(1-p_c)} \;=\; \alpha + \beta ACOL \;, \qquad \text{(A-6)}$$

where *ACOL* is estimated in three components with three different βs. These components are referred to below as Netpay, Civilian Hires, and Unemployment Rate.

Table A-1 shows the mean values for the variables and the estimated coefficients for the specification used in the simulation model. In this model, dummy variables for Jet and Prop pilots are interacted with the pay variable to allow for pay to affect the three communities differently. The total effect of pay in the Jet and Prop communities is the sum of the Netpay and interacted variables. In the Helo community, the total effect is indicated by the Netpay coefficient by itself. The negative signs on the Jet and Prop interacted terms indicate that, in these communities, pay has a smaller effect on continuation than in the Helo community.

Table A-1

Estimation Coefficients for the Continuation of Pilots

Ind. variables	Mean value	Coefficient	t-statistic
Intercept	-	-.759	1.82
Netpay	93.6	.022	14.92
Civilian hires	4.3	-.069	3.4
Unemployment rate	7.3	.143	3.32
Jet pilot * Netpay	35.3	-.007	7.81
Prop pilot * Netpay	28.8	-.006	7.20

NOTE: Pay and Civilian hire variables in thousands.

The signs on all of the main *ACOL* variables were as expected: increases in Netpay and the Unemployment rate cause an increase in the continuation rate, and increases in Civilian hires cause a decrease in the rate. The t-statistic on all of the coefficients is above 2, which indicates that all these coefficients are statistically different from 0 at the 95-percent level. These coefficients have been installed in the ADSO model, described above, to help simulate the effect of changes in conditions on the aviation community.

In table A-2, the coefficients from table A-1 are transformed into slopes and elasticities. The transformations are made using the continuation rate in the sample of 0.81.

Table A-2

Slopes and elasticities with respect to continuation

Variable	Slope	Elasticity
Jet pay	.0023	.266
Prop pay	.0023	.269
Helo pay	.0033	.384
Civilian hires	-.0107	-.044
Unemployment rate	.0220	.198

NOTE: Pay and Civilian hire variables in thousands.