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Reassessing the Air Force's Selective Re-enlistment Bonus Program

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September 2010

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**REASSESSING THE AIR FORCE'S SELECTIVE
RE-ENLISTMENT BONUS PROGRAM**

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Submitted in partial fulfillment of the requirements for the degree of

MASTER OF BUSINESS ADMINISTRATION

from the

**NAVAL POSTGRADUATE SCHOOL
September 2010**

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REASSESSING THE AIR FORCE'S SELECTIVE RE-ENLISTMENT BONUS PROGRAM

ABSTRACT

The objective of this MBA project is to reassess the Air Force's current Selective Re-enlistment Bonus Program and provide a possible alternative for the compensation calculation. To find that alternative method of calculation, the goal of this project was to create an experiment using a second priced sealed bid auction. The experiment would provide an insight to truth revealing compensation requests for future job continuation. This essential tool will allow the Air Force to begin the determination of how to retain vital active duty service members through compensation bonuses while minimizing overall personnel costs to the Department of Defense.

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LIST OF ACRONYMS AND ABBREVIATIONS

AFPC	Air Force Personnel Center
AFQT	Armed Forces Qualification Test
AFSC	Air Force Specialty Code
AIP	Assignment Incentive Program
COLA	Cost of Living Allowance
DoD	Department of Defense
EPR	Enlisted Performance Reports
FPSB	First-Price Sealed-Bid
GED	General Educational Development
NPS	Naval Postgraduate School
QRMC	Quadrennial Review of Military Compensation
RMC	Regular Military Compensation
SPSB	Second Price Sealed Bid
SRB	Selective Re-enlistment Bonus
UIF	Unfavorable Information File
USDA	U.S. Department of Agriculture
WTA	Willingness-to-Accept

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I. INTRODUCTION

A. PURPOSE

According to the National Council of Disability (2009), more than 1.6 million American service members have deployed to Iraq and Afghanistan in support of ongoing military operations, such as Operation Iraqi Freedom, in response to the terrorist attacks on September 11, 2001 (p. 1). The ability for the Department of Defense to maintain the required force levels to continue conducting current operations rests heavily on recruiting and retaining service members. With the constant increases in the timeframe deployed and the frequency of deployments, many analysts and policymakers are concerned that ongoing operations will have a damaging effect on recruiting and retention and the military will fall short of its end strength requirements.

One of the many ways the Department of Defense is counteracting this potential shortfall is through increases and additions in compensation to the service member for their undivided loyalty to the U.S. government. One type of additional compensation, and the most costly to the Department of Defense, is in the form of enlistment/Re-enlistment bonuses. The intention of these bonuses is to compensate service members in specialties that are deemed “critical” within each service department. There are many factors involved, to be discussed in detail in later chapters, when computing the bonus amount received by the service member in these critical specialties. In providing this additional compensation, however, military personnel costs may increase significantly enough to “crowd out” projected increases in procurement funding for more technologically advanced systems needed to maintain superiority. The Congressional Budget Office estimates that military personnel appropriations are likely to increase at an average annual rate of about 1.6 percent in real terms between FY 2006 and FY 2024. This would increase funding from \$113 billion in FY 2006 to some \$147 billion by FY 2024 (2006, p. 19).

To maintain a level of readiness required to support the ongoing military operations, the Department of Defense is challenged with balancing both recruiting and retention issues, the increase in personnel costs and the need for newer weapon systems. The purpose of this project focuses on the added costs associated with the retention issues currently faced by the Department of Defense, mainly in the Air Force. It provides the Department of Defense an alternative method for calculating the Selective Re-enlistment Bonus (SRB) in anticipation that it will help slow the future growth in military personnel costs. The alternative method examined in this project involves a separating auction mechanism, which combines a portfolio of two Re-enlistment contracts of different lengths with a two-stage auction procedure, which both determines bonus amounts and identifies service members to be offered each Re-enlistment bonus.

B. RESEARCH QUESTIONS

1. Primary Question

How might such a separating auction mechanism provide the Air Force with a cost effective alternative for calculating Re-enlistment bonuses, while retaining quality Air Force military members?

2. Secondary Questions

In order to fully address the primary question, several secondary questions will have to be answered. These questions include current issues dealing with retention and the current Selective Re-enlistment Bonus Program; compensation currently available to military members; potential improvements through different types of auctions and asymmetric information analysis; experimental investigation and the feasibility of incorporating the results of the experiment into a workable Air Force bonus program.

C. METHODOLOGY

This paper builds upon many previous U.S. Naval Postgraduate student theses. The foundation was based on, *Improving the Navy's Officer Bonus Program*

Effectiveness (Filip, 2006) and *Using an Experimental Approach to Improving the Selective Re-enlistment Bonus Program* (Norton, 2007). In the first report, author William N. Filip provides a thorough examination of bonuses used as a valuable tool in attracting and retaining naval officers. Filip uses information gained from current policies and research already conducted in the academic arena by combining auction theory and signaling theory into a separating auction mechanism that would provide the Navy with flexibility, quality and quantity of service members, and cost savings. In the second report, William J. Norton continues with this theory by providing insight on alternative compensation methods using an economic experiment that may mirror a service member's response to a retention decision.

Other documentation was reviewed which provided insight in current military operations. Such information provided a baseline for retention and recruiting issues among all branches of the service. The intent was to view the current situation and personnel growth predictions along with previous research on this particular topic and decide an alternative method for reducing those growth costs along with increasing service member's attitude toward the military.

D. SCOPE AND LIMITATIONS

This project's scope focused on enlisted service members in the Air Force. All branches of the service currently have a Selective Re-enlistment Bonus Program; however, methods for their calculation vary. To understand how the Air Force's program works, various articles and literature were reviewed and incorporated into this thesis. To achieve the desired results of this project, a two-stage reverse second priced sealed bid auction was created to be conducted for further research. The auction experiment itself creates the limitation on the particular subjects used.

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II. BACKGROUND—RETENTION

A. DEPARTMENT OF DEFENSE (DOD) RETENTION ISSUES/FACTS

As stated earlier, the ability to maintain continued presence in the Middle East requires the military to rely heavily on recruiting and retaining vital service members.

Each service branch has its own requirement for end strengths. For example, the Army is currently increasing its recruiting goals for additional personnel levels and number of combat brigades. The basis for this increase focuses on the heightened deployment ops tempo. Unfortunately, in FY 2005, the Army in particular did not meet that goal.

In FY 2006, many of the service branches were successful in meeting their recruiting goals, but at the expense of recruit qualifications, as the increased recruiting goals transitioned the focus for recruits from quality to quantity to meet the required end strengths. This shift in the quality of recruits is forcing the military to emphasize retaining those service members who currently meet the qualifications to perform in specialized “critical” jobs, which would take new recruits years to master.

Contrary to the Army, the Air Force is undergoing reductions in its end strength requirements. According to the 2006 Quadrennial Defense Review Report, it calls for “reducing Air Force end strength by approximately 40,000 full-time equivalent personnel with balanced cuts across the total force” (p. 47). The Future Years Defense Program matches that objective and outlines, shown in Table 1, a force size of 351,800 personnel for 2006 and of 334,200 for 2007, reflecting planned reductions of about 1,900 and 17,600, respectively (Congressional Budget Office, 2006).

Calendar Year	Air Force's End Strength
2005	353,696
2006	351,800
2007	334,200
2008	330,200
2009	324,100
2010	320,200
2011	316,500

Table 1. Plans for the Active Air Force's End Strength, as Specified in the FYDP (After: Congressional Budget Office, 2006).

According to Maj Gen Frank Faykes, Director, Air Force Budget, a reorganization of the force, including phased retirements of some older aircraft systems, is among the reasons for the reductions (Faykes, 2006).

B. AIR FORCE SELECTIVE RE-ENLISTMENT BONUS PROGRAM

Retention is a big concern for the Air Force. With the reduction in overall end strength, the Air Force still faces the challenges of retaining personnel with special skills in high demand. The following table illustrates the shortfalls faced by the Air Force's retention goals during the fiscal years 2000–2005. While retention may be less problematic in 2009 and 2010 under the current economic conditions, retention problems are likely to return to historic patterns when the economy recovery is complete.

Fiscal Year	Initial Enlistments			Midcareer Personnel			Careerists		
	Actual	Goal	Attainment of Goal	Actual	Goal	Attainment of Goal	Actual	Goal	Attainment of Goal
2000	53.1	55.0	No	69.7	75.0	No	90.8	95.0	No
2001	56.1	55.0	Yes	68.9	75.0	No	90.2	95.0	No
2002	72.1	55.0	Yes	78.3	75.0	Yes	94.6	95.0	No
2003	60.5	55.0	Yes	72.9	79.0	No	95.2	95.0	Yes
2004	63.0	55.0	Yes	70.0	75.0	No	97.0	95.0	Yes
2005	39.0	52.0	No	67.0	69.0	No	85.0	85.0	Yes

Table 2. The Active Air Force's Retention of Enlisted Personnel (After: Congressional Budget Office, 2006).

Enlisted personnel are organized in career zones. Zone A includes first-term, or initial enlistments, which involve airmen with less than six years of service; Zone B includes mid-career airmen between 6–10 years of service; and Zone C includes career airmen, careerists, between 10–14 years of service. As shown in the table above, the Air Force faces its greatest challenge in meeting its retention goal for mid career personnel. During the same time period, it met its retention goal for careerists half of the time and initial enlistments most of the time.

Many factors affect Air Force retention levels. Two such factors deal with the conditions of the current labor market and overall popularity of current military operations. A large segment of Air Force personnel are trained in aircraft and aviation skills, two highly demanded “critical” fields. These skills are very valuable and easily transferable to the private sector. When labor market conditions are favorable and unemployment is low, the Air Force risks losing those valuable assets to private companies willing to pay top dollar for those skills. On the same line, if the overall population's attitude toward current military operations becomes strained, many service members will feel pressured to separate in support of American's viewpoint.

In a time of end-strength reduction, there are different retention incentive tools available to all service branches to help retain personnel with highly demanded special skills, even while releasing other personnel. One such program is the Selective Re-enlistment Bonus Program, or SRB Program; a management tool designed to increase or maintain enlisted retention in critically manned specialties. Established by Congress in

1974, the SRB Program, currently targeting enlisted personnel, is the primary tool used for addressing the short-term retention problems faced by today's military. For FY 2009, this incentive allows the military to pay bonuses up to \$90,000 per enlistment to entice enlisted service members to Re-enlist for another term. The bonus amounts paid by the Air Force depend mainly on its needs for personnel in critical specialties and the length of the Re-enlistment. According to the Congressional Budget Office (2006):

Between 2000 and 2005, the Air Force's Selective Re-enlistment Bonus Program budget reached its highest levels in 2002 at \$232 million, 2003 at \$247 million, and 2004 at \$263 million; in those years, it met its retentions goals in more of the experience categories (initial enlistments, mid career, careerist) than during the other years of the period. Decreasing SRB expenditures to \$238 million in 2005 coincided with the Air Force's not meeting its retention goals in two of the three experience categories. For 2006 and 2007, the Air Force budgeted lower amounts, about \$214 million and \$195 million, respectively, presumably because of its planned end-strength reductions. (pp. 70–71)

C. AIR FORCE SELECTIVE RE-ENLISTMENT BONUS

The SRB is cash compensation designed to retain existing personnel in critical specialties, while attempting to entice other personnel from less critical specialties to retrain into critical specialties. Bonuses are offered by zones, A B and C as listed above, and within an Air Force Specialty Code (AFSC), thereby allowing targeted retention effects in the specific year groups.

In 1998, the Air Force designated 107 AFSCs as eligible to receive the SRB. By 2002, the number of AFSCs receiving the bonus increased to one hundred sixty-one. This responded to the end strength shortfalls in 1999 and 2000 and the Stop Loss program implementation after the terrorist attacks on September 11, 2001. By March 2005, the Air Force experienced higher than expected retention and exceeded its end strength requirements, which significantly decreased the number of eligible AFSCs to sixty-three. In 2006, the Air Force offered bonuses to 37 AFSCs. The following figure outlines those 37 AFSCs.

Air Force Specialty Code	Title
1A0X1	In-Flight Refueling
1A1X1X	Flight Engineer
1A2X1	Aircraft Loadmaster
1A3X1	Airborne Mission Sys
1A4X1X	Airborne Battle Mgt Sys
1A7X1	Aerial Gunner
1A8X1X	Airborne Crypto Linguist
1C1X1	Air Traffic Control
1C2X1	Combat Control
1C4X1	Tactical Air Comd&Cnt
1C5X1D	Aero Con/Warn Sys
1C6X1	Space Sys Operations
1N0X1	Operations Intel
1N1X1	Imagery Analysis
1N2X1	Comm Signals Intelligence
1N3X2A	Romance Crypto Lingst
1N3X3A/D	Slavic Crypto Lingst
1N3X4A	Chinese Crypto Lingst
1N3X4G	Korean Crypto Lingst
1N3X5X	Mid East Crypto Lingst
1N3X6X	African Crypto Lingst
1N3X7X	Turkic Crypto Lingst
1N3X8X	Polynesian Crypto Lingst
1N3X9X	Indo-Iranian Crypto Lngst
1N4X1	Network Intelligence Analys
1N5X1	Elect Signals Intel Exploit
1T0X1	Surv, Evas, Res, Escape
1T2X1	Pararescue
1W0X1	Weather
2G0X1	Logistics Plans
2T1X1	Vehicle Operations
3E8X1	Explosive Ord Dispos
3E9X1	Readiness
3P0X1A/B	Sf Mil Work Dog/Cmbt Arms
4J0X2	Physical Medicine
7S0X1	Special Investigation
9L0X0	Interpreter/Translator

Figure 1. Air Force's SRB Eligible Air Force Specialty Codes

Eligibility to receive an SRB requires the enlisted service member to be coded with one of the above AFSCs at their date of re-enlistment and that the service member

re-enlist for a minimum of two years, or up to a maximum of six years. Payment is received at 50 percent of the SRB value on their date of re-enlistment, with the remaining amount paid in equal installments over the re-enlistment years in service.

The monetary value of the SRB is calculated by the following equation:

$$\text{SRB Amount} = \text{Monthly Basic Pay} * \text{Years of Re-enlistment} * \text{SRB Multiple}$$

The monthly basic pay is based on the service member's rank/grade and time in service; the years of re-enlistment are the number of years the service member will remain on active duty, a minimum of two and a maximum of six; and the SRB multiple is offered in multiples of 0.5, ranging from 0.0 through 7.0 with higher multiples receiving larger monetary payments. The SRB multiplier determines the SRB value by allocating the authorized budget to those AFSCs eligible through an optimization model. This model is based on eligible AFSCs, retention shortfalls in those AFSCs, total budget costs, and constraints on increases in retention.

D. SELECTIVE RE-ENLISTMENT BONUS PROGRAM CONCERNS

While the current optimization model used by the Air Force can be modified according to the Air Force's retention needs, two problems exist. First, the optimization model focuses only on specific AFSCs and zones based on the needs of the Air Force within a given budget constraint. Holding years of re-enlistment constant, the SRB multiple identifies the severity of the re-enlistment problem within the specific AFSC and zone along with the level of pay authorized to deal with that problem. All service members within the same AFSC and zone level are compensated equally. Because the SRB and retention are interrelated when the optimization model sets the price too high, the Air Force exceeds its retention requirement within the specific AFSC; more eligible service members re-enlist to collect the bonus. The opposite is true, when the model sets the price too low, retention becomes a concern because too many service members

separate. The mission is to find the “right price” to retain the “right amount of people.” To alleviate this fluctuation, the Air Force needs to find a way to set the SRB price correctly to retain the desired number of service members.

The second problem with the current optimization model focuses on the actual fixed price paid to all service members even though many members would have re-enlisted for a much smaller SRB amount, resulting service members capturing surplus value or “profits.”

Ideally, the Air Force should avoid overpaying such service members and instead use those funds to pay higher SRBs to more qualified service member or other critical AFSCs to maintain a level of manning within those career fields. To retain more qualified service members the Air Force needs to place more importance on both sides of the labor market when determining SRB compensation prices and desired quality service members.

To address these problems, this research will take the current one-sided optimization mechanism and draw on both Auction Theory, in which the Air Force uses an auction to correctly set the marginal SRB price, and Signaling Theory, in which service members signal their re-enlistment intentions to the Air Force through a second round of auctions. The sequential auctions should set the marginal SRB at the level required to retain the desired number of service members, but re-enlist service members that are more willing to retain for a lower SRB.

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III. ACTIVE DUTY MILITARY PAY ENTITLEMENTS

To begin the discussion of retention compensation, it is important to first identify the different types of pay and allowances that military members receive. These entitlements are based on many different factors such as rank, dependent status, longevity and other special circumstances.

A. MILITARY PAY

Military compensation in the form of pay is the most tangible, immediate benefit of military service. There are three categories of military pay: basic pay, special pay, and incentive pay. All active duty enlisted members receive basic pay, however, special and incentive pays are only available to members performing specific duties or in specific duty locations. Military pay is also referred to as regular military compensation (RMC). Regular military compensation accounts for about 44 percent of total military compensation for the average active duty service member (Kosiak, 2006).

1. Basic Pay

Basic pay is the fundamental component of military pay. All service members receive it and typically, it is the largest component of a service member's military pay. Grade and longevity, or years of credible service, determines the amount of basic pay received. Wages are set not only to entice service members to promote to higher ranks, but also compensate for experience accrued through service time (longevity). For FY 2009, the monthly basic pay range from \$1399.50 for E-1s to \$6863.10 for E-9s.

Annual pay raises vary by fiscal year. For FY 2009, the President signed the Fiscal Year 2009 National Defense Authorization Act, which authorizes a 3.9 percent pay raise for all service members (DFAS).

2. Special Pay

Special pays are compensation to service members who perform specific duties and/or at specific locations. Compensation for more than one Special Pay is authorized and in addition to other pay and allowances. The following are just a few categories of Special Pay an enlisted service member may receive.

a. Special Duty Assignment Pay

Compensation paid to enlisted service members when performing duties designated by the Secretary of the Air Force as extremely difficult or involving an unusual degree of responsibility.

b. Enlistment and Re-enlistment Bonuses

The Air Force uses enlistment bonuses to attract new recruits into critical job specialties currently experiencing shortages for various reasons, including high qualification standards, unattractiveness of the job itself, and/ or the need for additional manning in a specific specialty. In exchange for a specified monetary bonus, new recruits are required to enlist for a period of at least two years.

Re-enlistment bonuses, as described in further detail above, are used to encourage service members already in an active status to re-enlist into critical specialties experiencing shortages. The monetary compensation for re-enlistment bonuses is based on experience zones, as stated above.

c. Hostile Fire or Imminent Danger Pay

Hostile Fire Pay is offered when a service member is subjected to hostile fire or explosion of a hostile mine, on official duty in close proximity to a hostile fire incident, or is killed, injured, or wounded by hostile fire, explosion of a hostile mine, or any other hostile action. Imminent Danger Pay is provided when a service member is on official duty in a designated Imminent Danger Pay area.

d. Hardship Duty Pay

Hardship Duty Pay is awarded to service members while performing duty designated by the Secretary of Defense as hardship duty. The Secretary of Defense has directed that Hardship Duty Pay shall be provided to service members for performing a designated hardship mission, when assigned to a designated location and/or when serving on a designated involuntary extension of duty.

e. Overseas Extended Tour of Duty

Monetary compensation is given to service members who are in specialties and at a location designated by the Secretary of the Air Force for the purposes of this entitlement, have completed an overseas tour of duty, and have extended the tour of duty for a period of at least one year.

3. Incentive Pay

In addition to both Basic pay and Special pay, service members may also be entitled to one or more of the following Incentive pays.

a. Aerial Flight Pay

Aerial Flight Pay, also known as Hazardous Duty Incentive Pay for Flying Duty, is awarded to service members in flying status who are on competent orders participating in regular and frequent aerial flights as crew or non-crew members.

b. Hazardous Duty Incentive Pay for Other Than Aerial Flights

Service members required to perform certain duties designated as hazardous, other than aerial flight, are entitled to receive this incentive pay. Those duties include parachute duty, flight deck duty, demolition duty, experimental stress duty, toxic fuels duty, toxic pesticides duty, dangerous viruses lab duty, and chemical munitions duty.

B. ALLOWANCES

Allowances are the second most important element of military pay entitlements. Allowances are provided for specific needs, such as food or housing. Monetary allowances are paid when the government does not provide for that specific need. The following are different types of allowances.

1. Basic Allowance for Subsistence

Subsistence allowance provides a monetary benefit to offset the cost of meals, when meals are not provided by the government. The amount of subsistence is based upon the U.S. Department of Agriculture (USDA) food cost index, which is adjusted annually and is identical for all enlisted service members.

2. Basic Allowance for Housing

Basic Allowance for Housing provides service members monetary compensation in lieu of quarters (housing). The allowance is based on geographic duty location, pay grade, and dependency status and is intended to represent accurate and equitable housing compensation based on housing costs in local civilian housing markets. Allowance rates are subject to cost increase and decrease in conjunction with the local rental housing market.

3. Family Separation

Family Separation comes in two forms.

a. Family Separation Allowance

Payable to service members with dependents or married to another service member for an enforced separation due to competent orders requiring permanent duty at a dependent restricted overseas tour or a temporary duty assignment for more than 30 days.

b. Family Separation Housing

Payable to service members for the additional housing expenses when assigned to a dependent restricted overseas tour and not assigned to adequate government quarters.

4. Clothing Monetary Allowance

By law and under Presidential Executive Order, enlisted service members are either furnished clothing or provided a monetary allowance to purchase such clothing on an annual basis. There are three basic types of clothing allowances: Initial clothing allowance issued to enlisted service members upon initial enlistment into the service; cash clothing replacement allowance provided to enlisted service members annually for replacement cost of required clothing items; and extra clothing allowance provided for unusual circumstances when a service member requires additional uniform items such as civilian clothing, to perform assigned duties.

5. Contiguous United States (CONUS) Cost of Living Allowance (COLA)

CONUS COLA is paid to service members as compensation for a portion of excess costs for non-housing expenses incurred in high cost areas. Qualification for this compensation is based on geographic duty location, mainly in major metropolitan areas and installations within CONUS.

6. Station Allowances

In some OCONUS areas, the average cost of housing and food are substantially higher than what is considered normal. To compensate for the higher costs, the service member may be authorized to receive one or more station allowances. They include the following.

a. *Temporary Lodging Allowance*

Authorized to partially reimburse a service member for both excess expenses while occupying temporary lodging and expenses for meals while using temporary lodging.

b. *Cost of Living Allowance*

Payable to assist service members in defraying the excess costs of goods and services incurred in high cost areas overseas.

c. *Overseas Housing Allowance*

Payable to service members for excess housing costs incurred.

d. *Move-In Housing Allowance*

An up front, one lump sum payment given to service members authorized OHA at an OCONUS Permanent Duty Station to cover average move-in costs.

IV. CURRENT RETENTION MECHANISM

A. THE SRB SELECTION PROCESS

The following information largely draws on Air Force Instruction: AFI 36-2606, 21 Nov 2001.

1. SRB Program

The SRB program is a financial incentive program paid to eligible enlisted service members to entice re-enlistments, or cross-training into undermanned critical AFSCs. The objective is to retain those service members who consistently demonstrate the capability to maintain high professional standards.

The authority to add or delete SRB candidate AFSCs belongs to the office of HQ Air Force DPRS (personnel/manpower); however, inputs are taken from the larger “in the field” groups, to include commanders, supervisors, Major Command staff, Air Force Personnel Center (AFPC) assignments teams, functional career managers, manpower experts, and Air Staff offices.

The SRB is available in specific AFSCs and zones and only one SRB is authorized per eligible service member. According to AFPC, the maximum SRB effective November 2009 is payable at \$90,000 per zone.¹

2. Eligibility Criteria

The SRB program is available to all enlisted service members, but only those re-enlistment-eligible (within the specified AFSC and zone level) will receive SRB consideration or reconsideration if previously ineligible due to time in service or because their AFSC was not previously offered for that particular rank. Unit commanders have total control on which eligible service members within their organizations will receive the

¹ The AFI publication has not been updated. The current amount was located at http://ask.afpc.randolph.af.mil/main_content.asp?prods1=1&prods2=2&prods3=2535&prods4=2537.

SRB payout by considering the service member's basic military standards, reviewing the Unfavorable Information File (UIF), if applicable, and evaluating duty performance and leadership abilities, normally observed through the service member's Enlisted Performance Reports (EPRs). Those re-enlistment-eligible enlisted service members that are non-selected by their unit commanders are not eligible for promotion and any projected line numbers will automatically be cancelled. In this situation, the service member will remain on active duty until such time as their enlistment commitment expires and will then be separated from the Air Force.

B. THE CURRENT MECHANISM

The current SRB optimization model is based on an equation that hones in on SRB payouts for undermanned critical AFSCs. The desired outcome is to pay the right compensation to retain enough service members to fulfill the required end strength for all Air Force career fields. The downfall of the current mechanism is that it is one-sided; essentially ignoring the Air Force's preferences over which service members to retain, beyond those not selected by their unit commanders, by offering all service members (regardless of quality) within each identified AFSC and zone level a single SRB payout amount.

The Air Force does recognize that there are variations among service member's willingness to re-enlist, as reflected by the service member's willingness to accept or the price a service member requires to re-enlist, but cannot reflect those preferences with the current mechanism. Therefore, it chooses to engage in its own price game--find the price that will retain the required number of service members to meet end strengths, or the "cheapest to retain." Later in this thesis, an alternative two-sided mechanism concept will be introduced that emphasizes preferences on both sides of the labor market, the Air Force and the service member. But first let's focus on the basics.

1. Basic Skill Combinations

There are two alternatives to a service member who is considering re-enlistment: remaining on active duty or leaving the military for a civilian job. Suppose there are two

kinds of skills (1) military-specific skills (e.g., flying aircraft, loading pallets into aircraft, disarming IEDs, etc.) and (2) general skills (e.g., managerial ability, accounting skills, etc.). Figure 2 provides a graphical view of potential skill combinations.

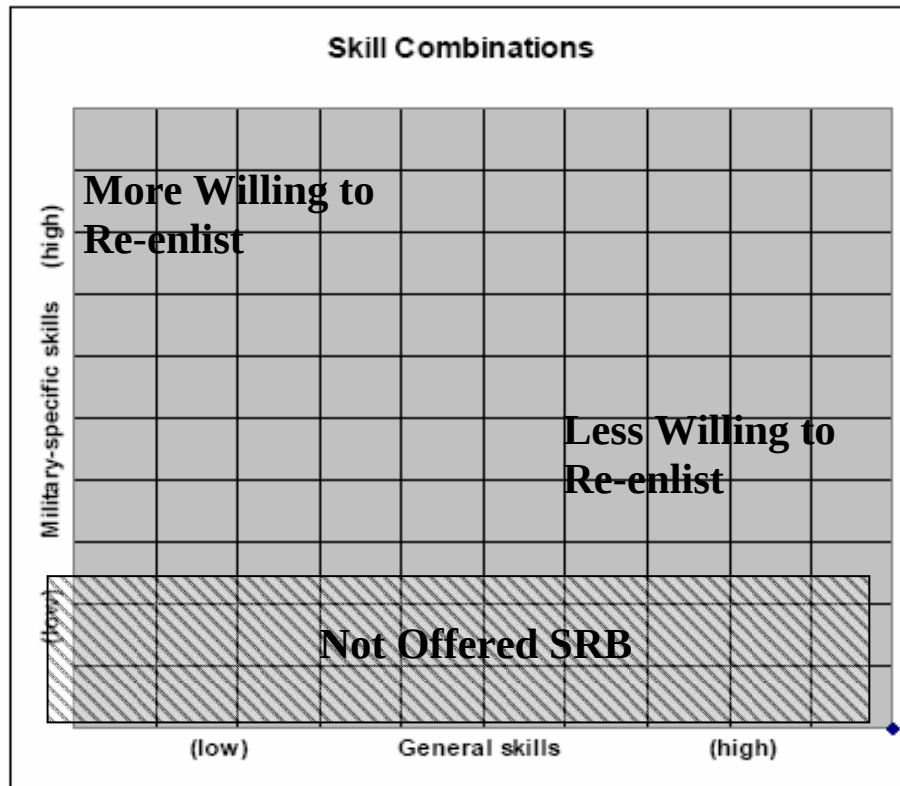


Figure 2. Skill Combinations

Ideally, the Air Force would like to retain service members who possess high levels of both skills (upper-right quadrant of Figure 2). These service members would be considered of the “highest quality.” However, because they have high general skills, those service members are more likely to succeed in a civilian (non-military) job, and are generally less likely (willing) to re-enlist without higher compensation (willingness to accept) to remain on active duty; the minimum re-enlistment bonus they would be willing to accept would likely be higher than that required by service members with high military-specific skills and low general skills.

On the other hand, those service members who possess lower levels of each skill (lower-left quadrant of Figure 2) are less desirable to both the Air Force and the civilian sector and would be willing to accept a very small or no bonus to re-enlist. These service members would be considered of the “lowest quality.” It is important to note there are basic standards that have to be met for a service member to remain on active duty. Those that do not meet those basic standards will be separated; not retained on active duty or receive the SRB (lower quadrant of Figure 2).

2. Meeting Retention Goals

As noted above, the current retention mechanism adapts a cost-effective one-sided concept; it motivates the following graph (Figure 3).

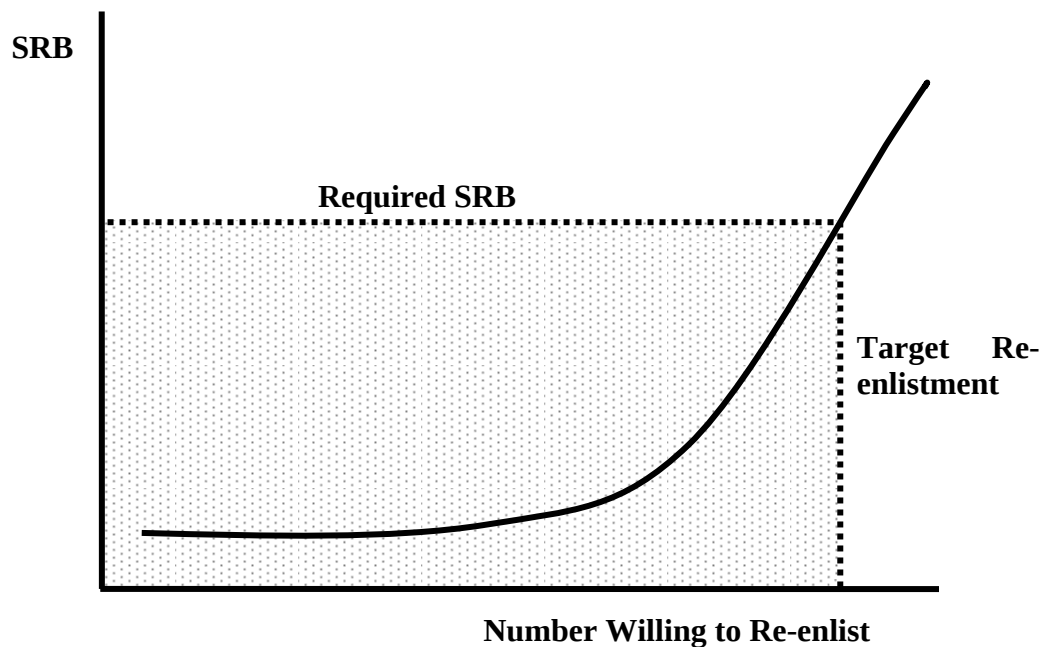


Figure 3. Single SRB Rate

This graph illustrates the difference in service members' SRB requirements to remain on active duty with the lower SRB payments corresponding to those most willing to re-enlist (high military specific skills, low general skills). The shaded area represents the cost to the Air Force to retain a specified number of service members at a constant SRB payment to all service members.

The Air Force's goal is to calculate the "right price" to induce a predetermined number of service members (end strength) to voluntarily re-enlist while keeping the integrity of an approved budget ceiling, as shown above. The "right price" for the "right number of people" is then determined and a single SRB is offered to the specified AFSC and zone level.

This mechanism only focuses on those service members "more willing to serve" or "cheapest to retain;" those with higher military-specific skills, lower general skills, (upper left quadrant of Figure 2) or those less desirable service members with the lowest quality. It generally fails to capture those higher valued, more expensive, service members whose required SRB is above the SRB offered. In other words, the outcome does not retain or discriminate based on quality, but only on cost effectiveness.

3. The Right Price for the Right Amount of People

Because service members have different SRB requirements to stay in the military, the current mechanism makes it difficult, if not impossible, to determine the precise SRB required to retain the precise number of service members desired. It becomes a mathematical/statistical guessing game creating the potential to significantly overshoot (surplus) or undershoot (deficit) both the targeted end strength and SRB paid (see Figure 4). Both outcomes inevitably lead to additional costs to reach the Air Force's desired end strength, along with the challenge of recalculating the required SRB to meet the desired end strength target. Additionally, the Air Force has little to no flexibility if corrections are needed. Adjustments to retention goals and SRB payouts are normally calculated using historical data on an annual basis.

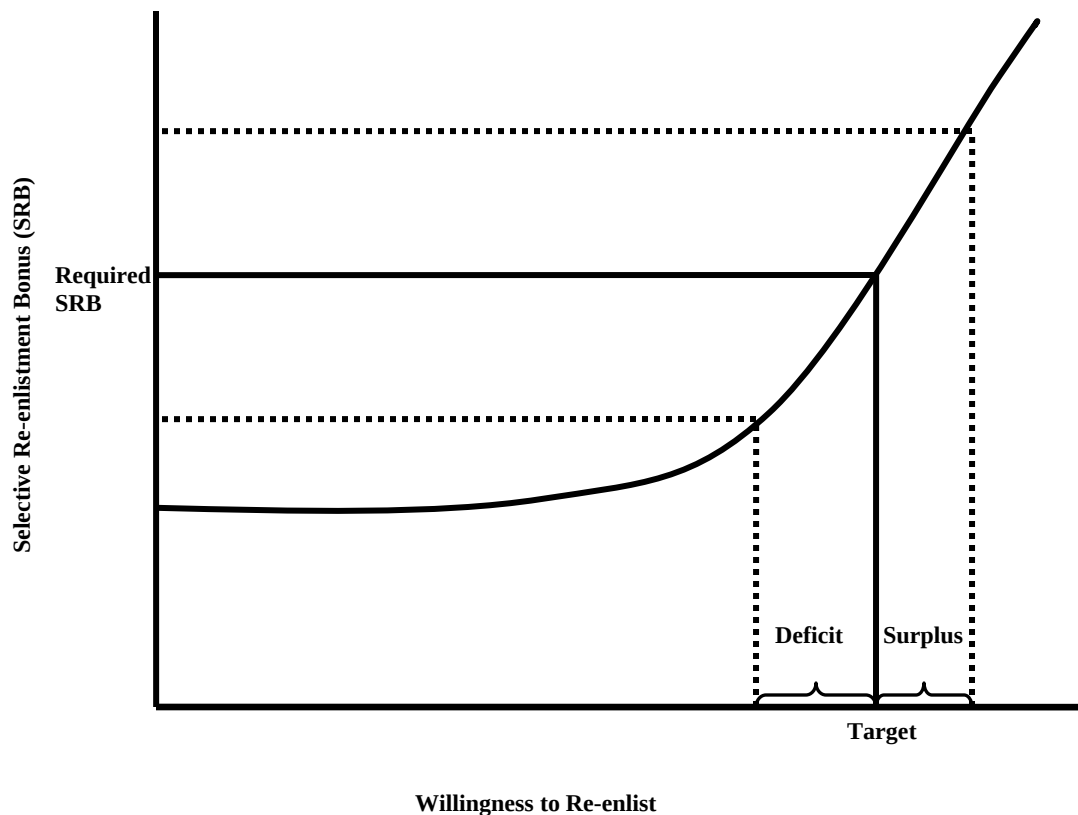


Figure 4. Resulting SRB Deficits and Surpluses

a. Deficit

If the outcome of the current mechanism creates an end strength deficit, the SRB was set too low and not enough service members voluntarily re-enlisted; therefore, the Air force failed to reach its re-enlistment target. The Air Force then faces shortages in those career fields deemed critical. Additional service members would still be needed to meet the target, creating the need for a higher SRB payout and/or non-voluntarily cross-training service members from other non-critical career fields; both significant costs to the Air Force. Again, despite the re-enlistment deficit, the single SRB offered to all service members may be significantly higher than most of the retained service member's willingness to re-enlist, representing an SRB overpayment to those service member.

b. Surplus

If the outcome creates an end strength surplus, two issues emerge. First, the Air Force retains too many service members in that AFSC, leading to one of two options--non-voluntary separation or cross-training the overage. Associated costs include some type of separation compensation or additional qualification training costs to learn a new trade, respectively. Second, because the outcome overshoot the required SRB, the excess SRB paid to each service member is an additional cost to the Air Force, well above the amount each service member may have required to re-enlist. In other words, even when the targeted end strengths are precisely achieved, service members with a relatively low willingness to accept receive an SRB exceeding their required SRB. If the SRB is set too high, each service member receives even higher compensation. This outcome creates an unnecessary overpayment to service members willing to retain at a lower required SRB.

C. FINDINGS

The Air Force's current retention mechanism has the propensity to hire the least cost, low quality service members. This mechanism does not retain or discriminate based on quality (assuming certain service members are above the minimum required quality), only cost-effectiveness. Furthermore, it is difficult, at best, to determine the precise SRB that will retain the targeted end strength. With the ever changing focus on economic and national security conditions, the military needs to have the flexibility to quickly adjust to those changes, in terms of targeted end strength and SRB required to meet that end strength. Another important factor is the quality of its service members. While it is difficult to maintain a specific quantity of service members, it is more difficult to capture the right quality service members using the current optimization mechanism. In the next chapters, this thesis will introduce the concept of an alternative method to better capture quality service members and reduce the Air Force's overall cost of retention.

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V. AUCTION AND SIGNALING THEORIES

While the Air Force desires high quality service members, setting the SRB too high may satisfy the Air Force's quantity and quality needs but overpays service members for their re-enlistment. In turn, setting the SRB amount too low will almost guarantee that all service members with higher general skills, including those with high military-specific skills, will not re-enlist but seek employment in the civilian sector. Using the current optimization model does not solve this problem, begging the question of whether an alternative mechanism using both auction and signaling theories can establish an appropriate bonus level.

Many U.S. Naval Postgraduate School students have conducted research on auctions, signaling/matching theory, and the combination of both theories for many of the DoD's military programs; from the U.S. Navy's Assignment Incentive Program (AIP) (Tan, 2006) and Officer Bonus Program (Filip, 2006) to the retention issues in the Marine Corps (Bock, 2007) and even the Australian Army (Cook, 2008). The outcome, though varied depending on program and methods used, has proven that using auction mechanisms verses traditional one-size fits-all SRB methods has proven positive in not only saving potential DoD dollars, but building a stronger foundation for continued research in putting the right people (quality) into the right jobs (quantity). To enable further discussions and future research on alternative mechanisms, this chapter will combine and reiterate the basics of auctions and signaling theory from those theses.

A. AUCTIONS

Auctions are based on a number of different factors; from the number of people bidding on goods, to the seller's end strategy on which auction will provide the biggest profit. Auctions have a basic vocabulary that remains constant regardless of auction types, rules, or outcome. Figure 5 illustrates the basic foundation for all auction types (Filip, 2006).

Forward Auction		Reverse Auction
Buyers	Bidders	Sellers
Seller (monopolist)	Bid-taker	Buyer (monopsonist)
High-bidder	Winner	Low-bidder
Maximum a bidder is willing to pay	Reservation Price	Minimum a bidder is willing to accept
Minimum a bid-taker is willing to accept	Reserve Price	Maximum a bid-taker is willing to pay

Figure 5. Auction Vocabulary as it Applies to Forward and Reverse Auctions

1. Participants

In each auction, there are bidders who compete with one another to achieve the winning price and bid-takers who receive the proposed offers from the bidders. In other words each auction has a seller who provides a good or service for a price and a buyer who wants that good or service and will pay the end price to the seller. Depending on whether the seller(s) or buyer(s) are the bid-taker or bidders determines which type of auction is used (forward or reverse).

2. Valuation

The value of an auctioned item and the means of expressing that value are important pieces in all auction designs.

a. *Common Value Versus Independent-Private Value Auctions*

In common value auctions, it is assumed that the value of the item being auctioned is essentially the same to every bidder, but that their estimates of this unknown value vary. In other words, the true value of an item is unknown until purchased;

therefore, each bidder places the same value on that item and adjusts his or her bid based on the bids of the other bidders assuming other bidders have more or less information about the item.

For independent-private value auctions, bidders have unique valuations for the item in question, which is unknown to other bidders; each participant will bid to exactly their own value for the object. The value of the item is not only different among the bidders, but the value placed by each bidder does not affect the value the other bidders place on that item.

b. Reservation Price and Reserve Price

In a forward auction, the reservation price is the maximum amount a buyer (bidder) is willing to pay for an item; in a reverse auction, it is the minimum amount a seller (bidder) would accept for an item.

The reserve price in a forward auction is the minimum a seller (bid-taker) is willing to accept for an item; in a reverse auction, it is the maximum a buyer (bid-taker) is willing to pay for an item.

3. Forward Versus Reverse Auctions

a. Forward Auctions

Forward auctions are the most commonly known auctions and involve a single seller, also known as a bid-taker, who puts a good or service up for sale to multiple buyers or bidders. As buyers increase their bids, it increases their chances of winning the auction, but decreases their surplus value (profit) if they win. The bidder who provides the highest bid wins the auction; the price they pay depends on other characteristics of the auction design (described below).

b. Reverse Auctions

In contrast, a reverse auction has a single buyer (bid-taker) and multiple sellers (bidders) who compete for the right to provide the item up for sale. As sellers

decrease their bids, it increases their chance of winning the auction, but decreases their surplus value (profits) if they win. The seller with the lowest bid wins the auction; the price they receive depends on other characteristics of the auction (described below).

4. First-Price verses Second-Price

a. First-Price Auction

In a first-price forward (reverse) auction, the winning bidder pays (receives) the highest (lowest) bid submitted; this is the price of the winning bid.

b. Second-Price Auction

In a second-priced forward (reverse) auction, the winning bidder pays (receives) the second highest (lowest) bid submitted; this is the first excluded bid.

5. Open Versus Sealed-Bid

An open auction is one where the actual bids are announced openly for all participants to observe. Mediums include auctioneers, the bidders themselves, or electronic means. This allows bidders to strategize based on other bids. Conversely, sealed-bid auctions are those auctions where bids are unknown to each competing bidder when submitted and all bids are revealed simultaneously.

6. Types of Auctions

a. English Auction

An English auction is the most commonly applied and recognized type of auction; it is an open-bid, first-price auction. If there are many buyers and one seller, it is an ascending-bid auction where the offered price is successively raised until reaching a price that only one bidder is willing to pay; the high bidder wins the item for sale and pays the winning bid.

b. Dutch Auction

A Dutch auction is the opposite of an English auction. It is a descending-bid action where an auctioneer announces a high initial price, which is successively lowered until some bidder announces his or her willingness to purchase the good or service at that price; the first bidder to express their willingness to pay the current price wins the item for sale and pays that price. As with English auctions, all bidders are aware of the current price for the item during the auction.

c. First-Price Sealed-Bid

In a first-price sealed-bid (FPSB) auction, bidders submit sealed bids which are unknown to other bidders. When there are many buyers and one seller (many sellers and one buyer), the highest (lowest) bidder wins the auction and pays (receives) the amount of his or her bid. With many buyers, the winning buyer will typically bid below his willingness to pay for the item in order to receive some surplus value; with many sellers, the winning bidder will need to bid above his minimum acceptable price, or willingness to accept, in order to receive a surplus.

To optimally balance the desire to maximize the chances of winning against the desire to maximize the surplus if he or she does win, the bidder tries to predict what others are likely to bid for the good or service; in particular, the price of the first excluded bidder. In a FPSB auction, “the bidder bids some amount less than his true valuation [with many buyers and one seller]: exactly how much less depends upon the probability distribution of the other bidders’ valuations and the number of competing bidders” (McAfee& McMillan, 1987). The opposite is true for an auction with many sellers; bidders will bid above their true valuation based on expectations of how others may bid.

d. Second-Price Sealed Bid

Second price sealed bid (SPSB) auctions resemble FPSB auctions in that bids are sealed and unknown to other bidders and, moreover, the highest bidder wins with

many buyers and the lowest bidder wins with many sellers. However, the winning bidder pays an amount equal to the first unsuccessful bid in the SPSB auction; the second highest bid with many buyers and the second lowest bid with many sellers. More generally, the price the winner (or winners) of an SPSB auction pays or receives is equal to the first excluded bid.

Note that an individual's bid in a SPSB auction determines whether he or she is the winner, but does not determine the amount paid/to be paid, which instead depends only on the bids of others. As a result (and after some analysis), it is easily shown that placing a bid that reflects one's true valuation is in the bidder's own best interest in any SPSB auction; this makes this auction both efficient and truth-revealing.

Now that the four types of auctions have been described, the question to the Air Force is which auction would use the SRB budget cost-effectively?

B. REVENUE EQUIVALENCE THEOREM

The answer to the above question is that "any" of the four auctions can be used to find the optimal price but they all involve the same cost to the Air Force, on average, according to the revenue equivalence theorem, which is an important finding in auction theory. The revenue equivalence theorem assumes all bidders are risk neutral and have their own independent values for the auctioned item (e.g., they all have independent valuations of the SRB they require to re-enlist). A buyer's valuation of a good or service is sometimes referred to as his or her willingness-to-pay while a seller's valuation of a good or service is sometimes referred to as his or her willingness-to-accept (WTA). If bidders are risk neutral and have independent valuations, the revenue equivalence theorem states that all four types of auction mechanism will be "revenue equivalent," resulting in the same expected cost (revenue), providing the item always goes to the highest (lowest) bidder.

Assuming revenue equivalence, auctions would allow the Air Force to set the SRB price correctly, but would not capture any of the surplus value captured by the service members more willing to re-enlist. Using a traditional auction to set the SRB for

specified AFSCs only solves one of the two problems discussed above. Using any of the four auctions would allow the Air Force to set the correct price for the SRB, but does not improve cost efficiency. To address cost efficiency, a more unique bidding auction strategy must be presented; one that captures at least some of the service members' surplus value through some mechanism that signals which service members are more willing to re-enlist. The next chapter will focus on signaling theory.

C. ASYMMETRIC INFORMATION

As stated previously, auctions can be a vital force shaping tool used to retain the right number of service members and set the bonus required to retain those service members to satisfy end strength requirements; however, using auctions alone still does not resolve the issue of cost effectiveness; the Air Force is unable to determine who it is most cost effective to retain.

1. Background

In many life transactions, the people involved have different information and in many situations one side of the interaction knows something that the other does not; this is known as asymmetric information. In market situations, potential buyers maybe unaware of the true value of the transaction or what other buyers are willing to pay; whereas the seller is fully aware of the item's characteristics, but not what the buyers are willing to pay. In many instances, the participants are aware that information is being withheld; in other instances, the unknown information might not be as obvious.

There are two broad types of asymmetric information that buyers and sellers might lack but desire; hidden characteristics and hidden actions.

a. Hidden Characteristics

Hidden characteristics are information that one side of the transaction knows; the other side is uninformed but desires to know that information. For example,

when buying a used car, the seller has a much better idea of the car's quality than the buyer and may withhold unfavorable information about the car. In most cases, the seller will know more about the item being sold than the buyer.

There are, however, situations in which the buyer is the better informed party. Take the life insurance market for example, buyers have a better idea concerning their health and family history than the insurance company selling the policy. In both situations, there is hidden characteristics that the uninformed party desires, but may not know.

b. Hidden Actions

The second type of asymmetric information occurs when one side of the transaction takes an action that the other side cannot observe, but affects them directly. In the labor market, for example, firms focus on hiring potential employees who will produce high quality work and remain professional. What the employee does during the work day may not be observable at all times and actions, such as shirking, may occur. In this situation, there are actions in which one party may participate that the uninformed party may not recognize, but desire to know.

2. Competitive Market Signaling

One way to reduce the affects of hidden characteristics and actions is finding certain indicators that provide the uninformed party insight into the informed party's motivation. This is called signaling.

To understand the phenomenon of signaling, it is helpful to note the difference between asymmetric and symmetric information using a labor market example. Suppose workers' ability is easily observable to the workers and their employers. Given this symmetrical information and a perfectly competitive market, all workers hired could be paid based on their observable ability; lower-ability workers could be paid a lower wage and higher-ability workers could be paid a high wage.

With asymmetrical information, a potential worker's ability is not easily observable. She may know her ability to perform the required duties, but the firm has no way of determining whether she is of high- or low-ability at the time of hiring. When hiring a worker under this situation, a firm faces a chance that the worker is of either high- or low-ability. This becomes the main concern for firms when these positions are highly competitive and the firm's ultimate goal is to hire high-ability workers. Without additional information identifying the higher-ability workers, those individuals face the risk of losing competitive positions to lower-ability workers.

To combat this issue, high-ability workers must send a signal that low-ability workers find it difficult or impossible to send. So how can firms better judge potential workers? Michael Spence in *Market Signaling: Informational Transfer in Hiring and Related Screening Processes* (1974) makes the inference that going to school may be a relevant signal in labor markets.

The cost of secondary education includes both monetary costs, such as tuition, and non-monetary costs, such as effort. If work ability and ability in school are closely related, then attending school may be costlier for low-ability individuals who find it more of a struggle and have to study harder. Therefore, low-ability workers would need greater compensation to complete secondary education in relation to high-ability workers, making their investment for secondary education exceed their benefits; low-ability workers will choose not to attend college and accept lower paying employment. Even though education does not enhance ability, it does signal ability, and workers may use education to distinguish themselves from one another.

There is considerable evidence that using education as a signaling model is widely popular. Corporate America has come to rely on the college degree as the safest guarantee that an applicant has the skills, discipline and maturity to tackle the job (Uchitelle, 1990).

D. APPLICATION TO THE AIR FORCE

In the case of retention (recruitment), both the Air Force and service member (recruit) have information that is useful to the other party. The Air Force is better informed about the extent of the military's end strength requirements and has insight into the ability to retain (recruit) a given quantity of service members. Service members (recruits) gain this insight by observing the fluctuating trends of the eligible AFSCs and SRB levels (end strength fluctuations or increased budgets identified to increase recruitment goals). A pattern of rising bonus levels, end strength increases, or AFSCs authorized to receive the bonus, could signal a period of increasing competition from the civilian sector.

On the other hand, the service member (recruit) is better informed than the Air Force about their personal preferences, willingness to re-enlist (enlist), and ability; information that cannot be observed by the Air Force but is vital in cost-effectively retaining quality service members.

According to The Tenth Quadrennial Review of Military Compensation (QRMC) (2008), DoD used signaling theory in FY 2007 to address hidden characteristic issues in recruiting. DoD's goal was to recruit high quality service members "that can be trained for increasingly complex and high-technology-based tasks" (p. 27). Two measurements were used to signal quality: educational achievement, the proportion of those who obtained High School diplomas, and training aptitude, the scores recruits received on the Armed Forces Qualification Test (AFQT).

DoD found that recruits who graduated from high school verses obtaining a General Educational Development (GED) certificate or not graduating have a higher probability of completing their first term of enlistment. Additionally, those recruits who scored at the 50th percentile or higher (Categories I-III A) on the AFQT tend to learn more quickly and effectively in training and subsequently perform better on the job. With these conclusions, benchmarks were established for the two measurements: ninety

percent of new recruits should have high school diplomas, and 60 percent should score in Categories I–IIIA on the qualification test; the highest quality recruits have a combination of both measurements.

Based on the QRMC, the DoD views recruiting quality service members as a challenge now and in the future, with continued focus on labor market conditions, youths’ viewpoint toward current military operations, veterans’ opinions, higher educational opportunities, and competition with labor market compensation as a means to determine potential recruits’ signals.

This confirms that DoD recognizes the importance of higher standards when enlisting members to critical AFSCs. Is that enough effort for DoD to answer the question regarding recruiting the right quality and quantity of service members? Or is an alternative mechanism needed to further improve the quality of service members recruited? Further research may be needed to fully answer those questions.

Regarding retention, service members can only signal their intent to re-enlist by either accepting the re-enlistment or separating from the military under the current Optimization model. Their decision is based purely on the amount the Air Force offers to pay for their labor and their perceived reservation price, or willingness to accept that payment. On the other hand, the Air Force does not have the capability to choose who to retain based on its preferences between higher and lower quality service members or to pay service members different SRBs based on their willingness to accept.

The Air Force can use a similar approach as in recruiting, but the basic standards or factors used to determine quality, a high school diploma and/or AFQT scores, at this point have already been met. Additionally, using traditional auction theory as a force-shaping tool can ensure a more precise targeting of the required Air Force end strength; however, traditional auctions do not fully minimize costs. In particular, traditional auctions avoid the undesired results the Air Force faces when the SRB is set too high or too low; but they involve potentially significant income transfers from the Air Force to the service members.

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VI. EVALUATIONS OF ALTERNATIVE AUCTION MECHANISMS

A. INITIAL PROPOSED MECHANISM

To allow information to become more symmetrical and cost efficient, this research initially developed a two-stage separating auction mechanism incorporating both auction and signaling theory (Appendix). The mechanism was set up like a independent private-valued reverse second price sealed bid auction where the military is the one buyer or bid-taker for labor services and eligible service members are the many sellers or bidders (of labor services).

The first auction sets the SRB level to meet the Air Force's overall re-enlistment goals, as in Figure 3; the second stage determines a lower SRB amount offered to service members willing to re-enlist at a lower price but with the guarantee of a longer service commitment contract. The intent is to capture those members more willing to re-enlist, either service members with a strong preference for military service, or service members with high military specific skills/lower general skills who possess less attractive civilian opportunities; these categories of service members should be willing to forgo some SRB payout to ensure they are employed for a longer period of time. As stated earlier, those service members who do not meet the basic performance requirements are separated and not eligible to re-enlist or receive the SRB. This concept is illustrated in Figure 6.

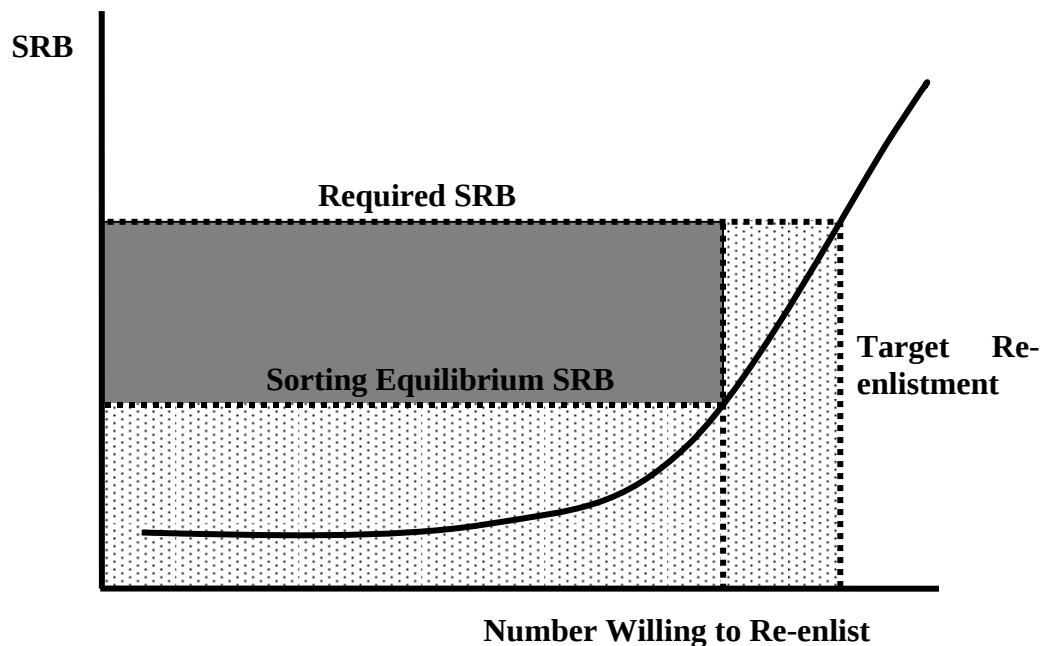


Figure 6. Initially Proposed Mechanism

The outcome of the two-stage separating auction mechanism shows the Air Force's cost (dot shaded area in Figure 6) to be significantly lower, more cost-effective, than the current SRB retention model and traditional auctions (the cost savings are the solid shaded area in Figure 6). Unfortunately, this mechanism only retains those lower cost service members, not necessarily the higher quality service members the Air Force may desire.

Experiments reported by Cook (2008) show that actual bidding behavior corresponds closely to the theoretically predicted behavior. These experiments were conducted using both enlisted Marines at the Defense Language Institute in Monterey, CA and military officers at the Naval Postgraduate School in Monterey, CA. Bidders truthfully reveal their opportunity costs in the first round second-price sealed-bid auction. Projected savings from the second round auctions approaches 25–30 percent in these experiments.

What if the Air Force was able to discriminate between higher and lower quality service members, pay lower bonuses for lower quality members and larger bonuses (possibly beyond the current Required SRB) for higher valued members?

B. ALTERNATIVE AUCTION MECHANISMS

Many salary determination studies for the Navy's retention and assignment processes have been done using alternative auction mechanisms. The research tailored those mechanisms towards finding the answer to the service member quality question above; how to capture the Navy's valuation of sailors and adjust compensation, both monetary and non-monetary, accordingly. This section introduces the findings of those studies and begins the research on the potential success if the Air Force aligned the current retention mechanism towards the results of the Navy's retention and assignment processes.

1. Preferences: Two-Sided Mechanisms

One of the key ingredients the current retention mechanism lacks is the ability for the Air Force to express its preferences over the quality of sailors to retain. Again, it has been determined that using auction mechanisms, particularly a Second Priced Sealed Bid Auction, can better assure the right quantity of sailors for those critical AFSCs and provide a more cost effective means of determining the required SRB payout for the targeted end strength. This indication has proven that the current retention mechanism, traditional auctions, and the initial proposed mechanism are all one-sided mechanisms, meaning that only the sailors have the ability to express their preferences on whether to re-enlist or separate based on the SRB offered.

To introduce the importance of a two-sided mechanism, a former Naval Postgraduate School (NPS) student (Robards, 2001) recognized the need to obtain a better, more cost-effective preference-oriented assignment process for the Navy. He explored the notion of a two-sided mechanism as a possible alternative means of assigning sailors to billets by examining the similarities and difference between a two-sided matching process and the current Navy assignment process. With various

modifications to the processes, his findings supported the notion that a two-sided mechanism is not only cost effective, but improved the overall quality of assignments. To further enhance the process, Robards suggested incentives such as monthly cash payment, additional annual leave, or promotion and assignment points to encourage sailors to fill critical hard to fill positions (p. 52).

In Robards' model, sailors seeking jobs submit their rank-ordered preference list for the jobs available; the commands with open billets similarly submit their rank-ordered preference list for the available sailors (possibly automatically generated according to the sailors' characteristics and the command's preferences over those characteristics). These lists are inputs to a matching algorithm that develops stable matches. Stable matches require that the sailor and the command must both prefer their current match than any other match they can individually negotiate (i.e., the sailor and the command cannot both find a preferred alternative to the current match). The matching algorithm can favor the sailors' preferences (the sailor-optimal model) or the commands' preferences (the billet-optimal model).

To further define this research, a second student (Tan, 2006) reiterated the benefits of using a two-sided auction mechanism, identified the two complications of using an assignment auction affecting the incentive of bidders to submit their truthful valuation of billets, and simulated an alternate auction mechanism that combined both auction and matching theories to capture those benefits of a two sided auction while solving the two complications of bidder truthfulness.

Tan's model incorporated money into the matching solution. In particular, sailors specify their required SRB (willingness to accept) for each billet in which they are interested. Lower SRBs reflect billets the sailor is more willing to accept; the required SRB can be zero. Similarly, commands express the SRB they are willing to pay for each available sailor; higher SRBs are associated with more desirable sailors. The matching algorithm then either maximizes the sailors' aggregate total surplus or the commands' aggregate total surplus, adjusting SRBs for oversubscribed billets or over demanded sailors, until each sailor is assigned to one billet and each billet receives no more than one sailor. Again, this process results in stable matches between sailors and commands.

2. Proposed Models

Using the concept of two-sided mechanisms, Robards (2001) concluded that a “Many-to-One” matching model, many sailors employed by one service, was the appropriate model for sailor assignments. This model motivates the sailor-optimal and billet-optimal models for which Tan (2006) developed a simulation model to test the mechanism’s performance. The following was discovered.

a. Sailor-Optimal Model

Under this model, the mechanism provides the sailors as a group with their best possible stable billet fit (maximizes aggregate sailor surplus). This approach, as noted by Tan (2006), motivates sailors to submit their true valuation (minimum acceptable SRB) for each of the billets; the sailors’ dominant strategy is to state their true minimum willingness to accept for each acceptable billet. The initial payout (incentive pay) is equal to the billet’s willingness to pay for that sailor, for all sailor/billet combinations, and decreases for over-subscribed billets until all billets are filled with no more than one sailor. This motivates sailors to bid truthfully to receive his preferred billet. Sailors cannot benefit by inflating their willingness to accept values in the sailor-optimal method. Their SRB for their matched billet depends on the billet’s willingness to pay for that sailor; the sailor’s required SRB only determines the billet to which the sailor is matched. Inflating a sailor’s willing to accept would not increase the SRB but may preclude a preferred match (Resare, 2007). From the Navy’s perspective, the sailor-optimal mechanism is not necessarily truth-revealing (commands can potentially benefit by misstating their willingness to pay), and it is more expensive than the billet-optimal model.

b. Billet-Optimal Model

The billet-optimal model provides billets as a group with the best possible sailor fit (maximizes aggregate billet surplus). This mechanism is not necessarily truth revealing for sailors, but more cost effective and truth revealing for the Navy. Initial SRBs are set equal to the sailors’ willingness to accept instead of the billets’ willingness

to pay. The SRB (incentive pay) increases for over-demanded sailors until a stable equilibrium is reached with each sailor matched to just one job and no more than one sailor assigned to each billet. Under this model, sailors are less likely to be truth revealing and may overstate their bids to capture some of the Navy's surplus.

Tan's simulation model results show that the Sailor-Optimal Model is more costly (the sailor has a higher surplus value than with the billet-optimal model), it is also likely to be more incentive-compatible and thereby more truth-revealing, for both sailors and billets, than the Billet-Optimal Model (p. 48).

To retain the truth-revealing properties of a Sailor-optimal approach but shift the surplus back to the Navy, additional research is needed to modify the alternative auction mechanisms.

C. APPLICATION TO THE AIR FORCE

Initially, an experimental auction mechanism was created to combat the high-cost low-quality aspects of the current SRB optimization model. The basic mechanism introduced a cost-efficient method that could successfully transfer income back to the Air Force through a two-staged separating auction, which incorporated both auction and signaling theories. The results showed the Air Force's costs significantly decreased by providing a lower SRB payout for those service members more willing to re-enlist (requiring a smaller SRB). Unfortunately, this mechanism did not necessarily capture those higher quality service members preferred by the Air Force because it failed to distinguish across service members on the basis of service member quality (airmen more attractive to the Air Force). Using what we know about the Navy's potential approach for creating a better assignment process, the Air Force can take a similar approach to improve the quality of its retained service members. One possibility that builds on the Robards' and Tan's research is to modify the simple second-price sealed-bid auction by discounting the SRB bids for higher quality service members by a predetermined amount (potentially related to their qualifications). Service members would submit a bid for their required SRB and bidders would be ranked from lowest cost to highest cost; for higher quality sailors, the bids used in the ranking would be their actual bids minus their quality

adjusted discount. Once the low-cost bidders are determined and the first excluded bid identified, retained service members would all receive the first excluded SRB as a base; higher quality service members would also be paid their quality adjustment. This auction would retain the properties of the second-price sealed-bid auction described above, but provide a higher SRB to higher quality service members, increasing their retention probability.

By identifying the right two-sided mechanism, service members will be given the opportunity to indicate their preferences to remain on active duty and signal their quality level through mediums such as performance reports, promotion/CDC testing results, physical fitness scores, etc. In turn, the Air Force can indicate which AFSCs require certain qualities or qualifications and target more desirable service members to retrain into those identified AFSCs.

Additionally, the resulting retention mechanisms, as with the Sailor-optimal model used above, could allow the Air Force to maintain truthful revelation properties enabling a more precise SRB payout for those higher quality service members. Unfortunately, this model is less cost effective, potentially costing the Air Force more to capture higher quality service member; the trade-off between cost and quality is an issue for future research.

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VII. CONCLUSION

This thesis has proven ways for the Air Force to shift its current retention mechanism into a two-sided alternate auction mechanism, extending beyond the traditional simple auctions and the two-stage mechanism proposed in the Appendix. The discussion using draws on research conducted on the Navy's assignment and retention research programs. As proven in this research, along with research conducted by other NPS students, the Air Force's current retention mechanism poses many challenges. First, the current retention mechanism is one-sided; service members can express their preferences for re-enlistment by either re-enlisting or separating from active duty, but it ignores any Air Force preferences regarding the quality of the service member needed to fill critical AFSCs. Second, the current model is not cost effective; it not only pays an equal amount to all service members, it cannot predict the precise SRB payout required to meet its end strength retention target. Its design almost ensures payouts will be too high or too low, therefore further increasing costs to fix deficits or surpluses. Lastly, the model is set to only capture the lowest-cost service members, not necessarily the higher quality personnel, by setting the retention goal at the SRB required to retain a specified number of service members regardless of quality. These three challenges indicate that "fixes" to meet end strength targets may be more costly in the future.

Using auctions verses traditional SRB retention methods provides a better solution to finding the right price for the right number of people. Therefore, an initial mechanism, a two-staged separating auction which incorporated both auction and signaling theories, was introduced and shown to be a cost efficient means of setting the SRB at the right levels (two different prices were paid; one to retain service members for one year, or a shorter time period, and a lower price to guarantee retention for multiple years, or a longer time period). However, this mechanism only addressed one of the two original existing problems; it better predicted the right quantity of people while reducing cost associated with those retained. It was able to discriminate based on those service members willing to re-enlist for a lower SRB, but it failed to capture what the Air Force considers more valuable service members (the quality problem). This mechanism was a

step in the right direction, using auction and signaling theories, but still lacked the ability to capture both sides of the labor market to improve the quality of re-enlisted service members.

To combat this issue and further enhance the retention/assignment process, two-sided mechanism theory was introduced. The outcome created two additional models, which were tested to explore the trade-offs between cost and quality in service member retention. This additional process allowed both sides of the labor market, the military commands and the service members, to express their preferences when determining sailor to billet/billet to sailor benefits. Using the concepts from previous student theses that have addressed the Navy's Assignment Incentive Pay (AIP) process, the Air Force is now better equipped to enhance its own mechanisms and further exploit similar alternative two-sided auction mechanisms to capture the right price to retain the right quality of service members.

In all, this thesis has shown the movement to a more cost-effective mechanism by building on the current mechanism, introducing auctions mechanisms, and creating an initial proposed alternative auction mechanism. One major downfall to these mechanisms is their one-sided nature. Continuing the movement but providing additional two-sided mechanisms will enable the Air Force to better utilize and reduce the overall retention budget and capture those highly qualified service members needed to fill critical AFSCs.

APPENDIX. INITIAL PROPOSED MECHANISM

Scenario Background

You are 1 of 100 employees currently working for Firm A.
Your only other potential employer is Firm B.
You have no particular preference for Firm A or for Firm B.
You can easily switch employers at no cost or inconvenience to you.
No matter where you end up working, you will be retiring 5 years from now.
Your only goal for the next 5 years is to maximize your total income over that time span.

Downsizing at Firm A

Firm A will be downsizing over the next 5 years.
Firm A will begin by laying off 10% of its workforce immediately (10 out of 100 employees).
Firm A will lay off additional employees in future years, but the exact number is uncertain at this time.
Firm A will not be hiring any new employees (or rehiring laid off or departed employees) during this period.
Thus, if you choose to leave or are laid off from Firm A, there will be no opportunity to return to Firm A in later years.

Employment Offer from Firm B

Firm B has offered to employ anybody who leaves Firm A, whether they leave now or in later years.
If you leave Firm A now, you will work at Firm B for the next 5 years.
If you leave Firm A after year 1, 2, 3, or 4, you will work for Firm B for the remainder of the 5 year period.
This standing offer of employment at Firm B applies whether you leave Firm A voluntarily or are laid off.

Salary Offer from Firm B

Firm B has presented a confidential annual salary offer to each employee currently working for Firm A.
The offer presented to each employee represents the annual salary that he/she will receive if employed by Firm B.
Firm B has offered different annual salary amounts to different Firm A employees.
For each year that you work for Firm B, Firm B has offered to pay you the following annual salary:

Distribution of Salary Offers from Firm B

You do not know the salary amounts that Firm B has offered to other current employees at Firm A.
You know only that all of Firm B's salary offers are spread evenly and randomly over some range.
In other words, these salary offers are spread evenly & randomly between some lower bound & some upper bound.
You do not know the actual lower and upper bounds of the range of salary offers.
However, you do know that the salary offered to you by Firm B lies somewhere within this range of offers.
Thus, it is safe to assume that some of Firm B's salary offers to potential employees are higher than your offer above.
It is also safe to assume that some of Firm B's salary offers to potential employees are lower than your offer.

Future Salary Changes

Over the next 5 years, each employee's annual salary will only change if he/she changes employers.
In other words, Firm A will pay you the same annual salary for each year that you work there (no salary raises or cuts).
Similarly, Firm B will pay you the same annual salary for each year that you work there (no salary raises or cuts).
The annual salary that you receive at the two different firms, however, may be different.

Salary Survey at Firm A

The salary paid to any Firm A employee in previous years will have no influence on his/her future salary at Firm A.
Instead, the annual salary that Firm A will be pay to each of its retained employees will be determined using a survey.
Firm A is asking each of its 100 workers to specify the minimum annual salary that he/she would need to receive in order to remain with Firm A.
Firm A will then pay the minimum salary necessary to voluntarily retain 90 of its 100 employees for next year.
In particular, after collecting all 100 "salary requests" from its employees, Firm A will lay off the 10 employees who submitted the highest salary requests.
Each of the 10 employees laid off will immediately begin working at Firm B at the salary previously offered.
The remaining 90 employees will work at Firm A for at least one more year.
All employees retained by Firm A will be paid the same salary, regardless of the salary they requested.
These retained employees will be paid the lowest salary that was requested among the 10 employees laid off.
In other words, Firm A will pay all retained employees the 10th highest salary requested.
Note that this salary will be as high or higher than the salary requested by any of the 90 retained employees.

Your Salary Request to Firm A

You must now decide what annual salary to request from Firm A.
Remember that if your request is among the highest 10 of the 100 salary requests submitted, you will be laid off from Firm A.
If your salary request to Firm A is not among the 10 highest, you will continue to work for Firm A for at least one more year and will receive an annual salary equal to the lowest salary requested among the 10 employees not retained.
What annual salary do you request from Firm A:

Salary Request to Firm A:

PROCEED

IF SALARY REQUEST IS ABOVE 90TH PERCENTILE OF THE DISTRIBUTION:

Distribution of Salary Requests to Firm A

The *lowest* annual salary request submitted to Firm A by one of its other current employees was:

The *highest* annual salary request submitted to Firm A by one of its other current employees was:

The *10th highest* annual salary request submitted to Firm A by one of its current employees was:

Your Employer, Salary, and Income for the Next 5 Years

Your salary request was among the 10 highest requests submitted to Firm A.

Therefore, you will not be retained by Firm A and will instead be employed by Firm B for the next 5 years.

Each year, you will receive the annual salary offered to you by Firm B previously.

Thus, your income over the next 5 years will be as follows:

Year 1:	
Year 2:	
Year 3:	
Year 4:	
Year 5:	
Total:	

The total above is your experimental earnings for this period.

This total will be converted to actual earnings from participation in this experiment at the exchange rate of
\$100,000 of experimental income = \$1 of actual earnings

Please wait until instructed to do so before clicking on the button below.

Proceed

IF SALARY REQUEST IS BELOW 90TH PERCENTILE OF THE DISTRIBUTION:

Distribution of Salary Requests to Firm A

The *lowest* annual salary request submitted to Firm A by one of its other current employees was:

The *highest* annual salary request submitted to Firm A by one of its other current employees was:

The *10th highest* annual salary request submitted to Firm A by one of its 100 current employees was:

Recall that this 10th highest salary request is the lowest request submitted among the 10 employees not retained.

Your Employer and Salary for the Next Year

Your salary request was not among the 25 highest requests submitted to Firm A.

Therefore, you will be retained by Firm A for the next year.

Your salary for this first year will be equal to the 25th highest salary request submitted to Firm A as given above.

Future Lay Offs at Firm A

Firm A will continue to reduce the size of its workforce in future years.

You estimate that Firm A will lay off the following percentage of its employees in each of the next 4 years:

Employees laid off from Firm A in future years will be selected at random.

Thus, the percentage listed above is also the probability that you will be laid off from Firm A in any given year.

Conversely, the probability that you will be retained by Firm A in any future year is equal to:

Your Employer in Future Years

Remember that if you are ever laid off from Firm A, you will be immediately employed by Firm B.

While you are certain to work for Firm A for at least the next year, you actually have 5 different possible patterns of employment over the next 5 years.

In particular, you could be laid off from Firm A after 1, 2, 3, or 4 years, or you could remain with Firm A for the entire 5 year period.

Each of these 5 patterns of employment and its associated probability is illustrated below:

	Pattern 1 Firm A for 1 Year	Pattern 2 Firm A for 2 Years	Pattern 3 Firm A for 3 Years	Pattern 4 Firm A for 4 Years	Pattern 5 Firm A for 5 Years
Probability of Pattern:	%	%	%	%	%
Year 1 Employer Firm:	A	A	A	A	A
Year 2 Employer Firm:	B	A	A	A	A
Year 3 Employer Firm:	B	B	A	A	A
Year 4 Employer Firm:	B	B	B	A	A
Year 5 Employer Firm:	B	B	B	B	A

Your Salary in Future Years

Each year that you are employed by Firm B, you will earn the annual salary previously offered to you by Firm B.

Thus, each of the 5 patterns of employment illustrated above has an associated pattern of annual salaries:

	Pattern 1 Firm A for 1 Year	Pattern 2 Firm A for 2 Years	Pattern 3 Firm A for 3 Years	Pattern 4 Firm A for 4 Years	Pattern 5 Firm A for 5 Years
Probability of Pattern:	%	%	%	%	%
Year 1 Salary:	\$	\$	\$	\$	\$
Year 2 Salary:	\$	\$	\$	\$	\$
Year 3 Salary:	\$	\$	\$	\$	\$
Year 4 Salary:	\$	\$	\$	\$	\$
Year 5 Salary:	\$	\$	\$	\$	\$
Total 5 Year Income:	\$	\$	\$	\$	\$
Annual Average:	\$	\$	\$	\$	\$

Your Expected (or Weighted Average) Annual Salary

As shown above, your average annual salary over the next 5 years could end up being any one of 5 different amounts.

To determine the annual salary you can expect (on average) during this period, you must calculate a weighted average.

The weighted average salary is calculated using the following two steps:

(1) Multiply each of the 5 possible annual average salaries by the probability of that particular pattern occurring.

(2) Sum these values over all 5 possible employment patterns.

In other words, your weighted average (or expected) annual salary is given by the following formula:

Weighted Average Annual Salary = $\text{Prob}_1 \times \text{Avg}_1 + \text{Prob}_2 \times \text{Avg}_2 + \text{Prob}_3 \times \text{Avg}_3 + \text{Prob}_4 \times \text{Avg}_4 + \text{Prob}_5 \times \text{Avg}_5$

Using the values from the first and last rows of the previous chart, your expected average salary is thus:

\$0

Possibility of a 5 Year Employment Guarantee with Firm A

As noted previously, your employment with Firm A (and the associated salary) is currently guaranteed only for 1 year. Your employer (and thus, your salary) in later years is uncertain with each possibility analyzed mathematically above. As an alternative to this uncertainty, Firm A will give a 5 year employment guarantee to half of its retained employees.

Another Salary Survey at Firm A

To determine which employees will be offered 5 year employment, Firm A will conduct another salary survey. This second survey will be conducted among only those 90 employees retained after the first salary survey. This second salary survey will determine:

- (1) which of the 90 retained employees will be guaranteed employment with Firm A for the next 5 years;
- (2) the annual salary that will be paid to each of these 5 year employees.

In this second survey, Firm A is asking each of its 90 retained employees to specify the minimum *annual* salary that he/she would need to receive in order to remain with Firm A for the next 5 years.

Firm A will then determine the minimum 5-year annual salary necessary for 45 of its 90 retained employees to voluntarily remain with Firm A for 5 years.

In particular, after collecting all the 5-year salary requests from its 90 retained employees, Firm A will give a 5 year guarantee of employment to the 45 employees who submitted the *lowest* 5-year annual salary requests.

The remaining 45 employees (those who submit the highest 5-year annual salary requests) will not receive a 5 year guarantee of employment.

The 45 employees given a 5 year guarantee of employment will each be paid the lowest 5-year annual salary that was requested among the 45 employees not given a 5 year employment guarantee.

In other words, the 45 employees given a 5 year guarantee of employment will each be paid the *45th highest* 5-year annual salary request that was submitted in the second salary survey.

For the 45 employees not guaranteed 5 year employment, the terms of employment with Firm A will remain unchanged.

In your case this means that if you are not guaranteed 5 year employment with Firm A:

- (1) You will still be guaranteed employment with Firm A for at least 1 year.
- (2) The probability that they will be laid off from Firm A in any year after the first is still equal to:
- (3) Your annual salary during any year that you are employed by Firm A will still be equal to:
- (4) If you ever laid off from Firm A, you will be employed by Firm B for the remainder of the 5 year period.
- (5) Your annual salary during any year that you are employed by Firm B will still be equal to:

%

\$

\$

Your Second Salary Request to Firm A

You must now decide what 5-year guaranteed annual salary to request from Firm A.

Remember that if your request is among the highest 45 of the 90 salary requests submitted, you will be laid off from Firm A and will work for Firm B for the next 5 years at the salary offer above.

Remember that if your 5-year annual salary request is among the lowest 45 requests in this second survey:

- (1) You are guaranteed to work for Firm A for 5 years.
- (2) You will be paid the 45th highest 5-year annual salary requested in this second survey.

If your salary request to Firm A is not among the 45 lowest, you will receive the previously determined annual salary for as long as you work for Firm A, but you will only be guaranteed employment at Firm A for the first year.

What 5-year guaranteed annual salary do you request from Firm A:

5-Year Annual Salary Request to Firm A:

\$

Continue

IF SECOND SALARY REQUEST IS ABOVE 50TH PERCENTILE OF THE NEW DISTRIBUTION:

Distribution of New Salary Requests to Firm A

The *lowest* 5-year annual salary request submitted among the other Firm A employees was:

The *highest* 5-year annual salary request submitted among the other Firm A employees was:

The *45th highest* 5-year annual salary request submitted among all Firm A employees was:

Your Terms of Employment for the Next 5 Years

Your salary request was among the 45 highest requests submitted to Firm A.

Therefore, you will not be given a 5 year guarantee of employment with Firm A..

Instead, you are only guaranteed to work for Firm A for one year.

At the end of each year with Firm A, the probability that you are laid off from Firm A is equal to:

%

If you are ever laid off from Firm A, you will work for Firm B for the remainder of the 5 year period.

Each year that you work for Firm A, your annual salary will be:

\$

Each year that you work for Firm B, your annual salary will be:

\$

Your Actual Employer, Salary, and Income for the Next 5 Years

In this section, your employer and salary for each of the next 5 years is determined based on the probability of being laid off from Firm A each year.

Your actual employer in each of the next 5 years is as follows:

Year 1:	Firm A
Year 2:	Firm A
Year 3:	Firm B
Year 4:	Firm B
Year 5:	Firm B

Thus, your annual salary and total income over the next 5 years is as follows:

Year 1:	\$
Year 2:	\$
Year 3:	\$
Year 4:	\$
Year 5:	\$
Total:	\$0

The total above is your experimental earnings for this period.

This total will be converted to actual earnings from participation in this experiment at the exchange rate of

Please wait until instructed to do so before clicking on the button below.

Proceed

IF SALARY REQUEST IS BELOW 50TH PERCENTILE OF THE NEW DISTRIBUTION:

Distribution of New Salary Requests to Firm A

The *lowest* 5-year annual salary request submitted among the other Firm A employees was:

\$

The *highest* 5-year annual salary request submitted among the other Firm A employees was:

\$

The *45th highest* 5-year annual salary request submitted among all Firm A employees was:

\$

Your Employer, Salary, and Income for the Next 5 Years

Your salary request was among the 45 lowest requests submitted to Firm A.

Therefore, you will be guaranteed employment with Firm A for the next 5 years.

Each year, you will receive the 45th highest annual salary requested in the second survey which is indicated above.

Thus, your income over the next 5 years will be as follows:

Year 1:	\$
Year 2:	\$
Year 3:	\$
Year 4:	\$
Year 5:	\$

Total: \$0

The total above is your experimental earnings for this period.

This total will be converted to actual earnings from participation in this experiment at the exchange rate of
\$100,000 of experimental income = \$1 of actual earnings

Please wait until instructed to do so before clicking on the button below.

Proceed

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