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THESIS

**USING A SECOND-PRICE AUCTION TO SET
MILITARY RETENTION BONUS LEVELS:
AN APPLICATION TO THE AUSTRALIAN ARMY**

by

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March 2008

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BONUS LEVELS: AN APPLICATION TO THE AUSTRALIAN ARMY**

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ABSTRACT

The Australian Army is attempting to improve retention rates, announcing a number of retention bonuses in 2007. In a service that has rarely used retention bonuses, historical data on the effectiveness of previous bonuses is limited. This thesis looks at both the effectiveness of retention bonuses in the U.S. Military, as well as an alternate method of establishing retention bonus levels with no historical data. It analyses an experiment where a sealed-bid, second-price auction is used to set salaries levels in a generic labor market scenario.

The experimental results support the literature: a second-price auction is a cost effective method of setting a retention bonus level. Without historical data and prediction techniques, a second-price auction allows the service to obtain the exact level of manning necessary at a value that more accurately reflects the value of the soldier. This reduces resource wastage. Cost effectiveness is further improved by adding a second auction for a longer term contract. While this analysis may be valuable to the Royal Australian Navy, Royal Australian Air Force and other volunteer militaries around the world, this thesis focuses specifically on application to the Australian Army.

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I. INTRODUCTION

A. PURPOSE AND OBJECTIVES

The Australian Army is trying to lift its retention rates as it attempts to grow the force. In 2007, the Australian Army announced a range of retention initiatives, including several bonuses designed to retain appropriately skilled personnel. In a service that has used retention bonuses on very few occasions, historical data on the effect of previous bonuses is limited. With little or no historical data, it is difficult to accurately predict the bonus necessary to retain a set number of soldiers.

All services of the United States Military have used retention bonuses extensively since the creation of its “All Volunteer Force.” The Australian Defence Force (ADF) can learn valuable lessons by analyzing the effectiveness of such bonuses in the U.S. Military. While these retention bonuses appear to be effective, scope exists to improve their efficiency and cost effectiveness. Recent research at the U.S. Naval Postgraduate School (NPS) considered improving the cost effectiveness by using an auction process to set the bonus amount. To date, this research has been largely theoretical.

This thesis analyzes experimental data where a second-price auction is used to set salary levels. Through this, as well analyzing the effectiveness of the extant U.S. Military retention bonus system, this thesis aims to improve the way in which the Australian Army sets and uses retention bonuses.

B. RESEARCH QUESTIONS

This thesis seeks to evaluate whether a sealed bid, second-price auction is viable in achieving retention objectives in the Australian Army.

1. Primary Research Question

The primary research question of this thesis is to determine if experimental results support the theory that a sealed bid, second-price auction is a cost effective means of setting military retention bonus levels.

2. Secondary Research Question

There are numerous secondary research questions necessary to consider the viability of an auction to set a retention bonus level. Specifically:

- What is the effect of an option to bid for a longer term employment contract? If such an option is presented with a second stage auction, would it further improve cost effectiveness?
- How would the results be affected if auction participants collude?
- Would training in the auction process be necessary or beneficial?
- How would an auction process be incorporated into the Australian Army's retention bonus system?

C. SCOPE

This thesis focuses on applying both theory and experimental data to retention bonuses in the Australian Army. The analysis may be equally valuable to the Royal Australian Navy and Royal Australian Air force, as well as the U.S. Military and other "all volunteer" militaries throughout the world; however, it does not specifically address the issues outside of the Australian Army.

D. METHODOLOGY AND THESIS OVERVIEW

This thesis begins by explaining the current scenario facing the Australian Army, where retention is currently a high priority. It then looks at how the U.S. Military has approached similar retention issues, using the available literature to analyze the effectiveness of the current program. Auction theory is then discussed to motivate a

possible alternative method to set retention bonus levels. A labor market second-price auction experiment conducted at the U.S. Naval Postgraduate School is then described and the data analyzed. The results of the data analysis will be used to propose a more cost effective retention bonus system in the Australian Army.

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II. INTRODUCTION TO THE RETENTION PROBLEM IN THE AUSTRALIAN ARMY

A. INTRODUCTION

The Australian Army is currently in a period of expansion. Vital to that growth is retaining more of the talented soldiers who make up the force. This chapter introduces the retention problem in the Australian Army and provides context to discussions later in the thesis. It begins by outlining the economic environment in which the expansion needs to occur, the expansion itself, the need for improved retention, and finally the Army's reaction to this need.

B. AUSTRALIAN ECONOMY AND LABOR MARKET

"The Australian economy is currently in the longest period of continuous expansion ever recorded" (Commonwealth of Australia, 2007a). Fifteen years of continuous economic growth has occurred, despite numerous shocks, such as the Asian financial and economic crisis, global economic slowdown in 2001 and two significant droughts (Commonwealth of Australia, 2007b), one of which continues to affect the country. With this economic growth, the unemployment rate has fallen from its peak in the early 90s, as can be seen in Figure 1. It recently reached a 34-year low, with the unemployment rate in February 08 falling to 4.0% (Australian Bureau of Statistics (ABS), 2008). Since 1996, an additional two million people are employed in the workforce (Costello, 2007). Labor force participation rates were at 65% in September 07 (ABS, 2007), slightly down from an all-time high one year earlier. At the same time, Australia finds itself experiencing a shortage of skilled labor, which is currently placing upward pressure on wages.

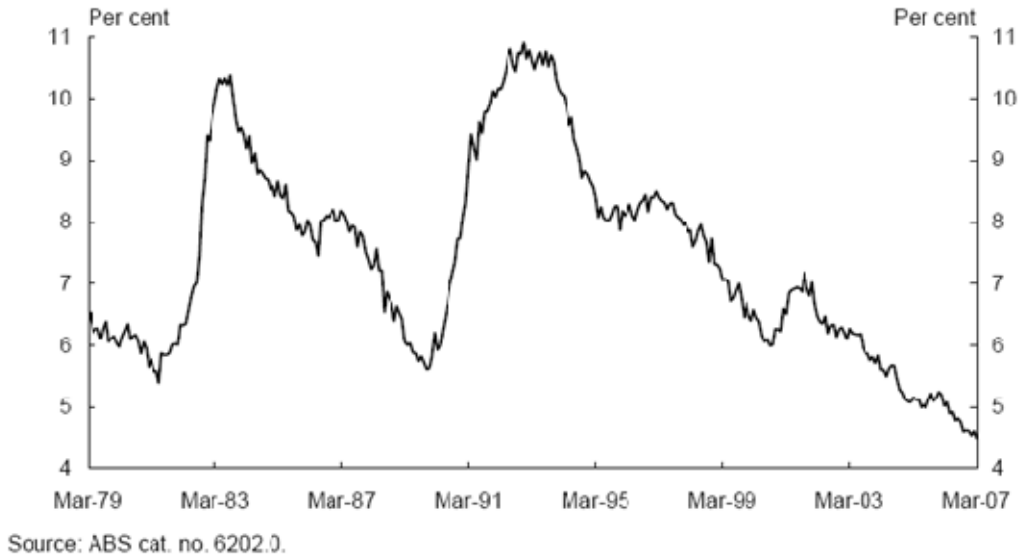


Figure 1. Australia's historic unemployment rate [From Commonwealth of Australia, 2007b]

C. EFFECT ON THE AUSTRALIAN DEFENCE FORCE (ADF)

As the modern battlefield changes, so too has the technology of combat. The effect is that the soldier of today must be more educated and highly trained than in the past. With a booming economy, low unemployment and a national skill shortage, highly trained ADF members suddenly become more attractive in the civilian industry. For service members, higher civilian wages in response to the national skill shortage may cause them to look to opportunities outside of the military. The end result is that the current strength of the Australian economy has made it harder to retain service personnel.

Not only is retention more difficult in the current economic environment, but recruiting also becomes challenging. With low unemployment and a high level of business activity, civilian industry captures a larger proportion of the young population that the ADF seeks to recruit.

In summary, while many sectors benefit from a strong economy and labor market, Defence suffers. In recent times, this has made retaining qualified and competent service

personnel and recruiting high quality applicants difficult. This is unlikely to change in the foreseeable future. Labor market issues are beyond Defence's control, and so it is important that strategies are in place to allow for adaptation.

D. EXPANSION OF THE ARMY

The Australian Army is currently enhancing equipment and personnel capabilities. Recruiting and retention have become increasingly more important as the Army seeks to meet its long-term manning goals. Based on the manning in November 2007, the Army is required to grow over 17% by 2016 (LTCOL P. Robards, personal communication, 22 Nov 2007). The Defence 2000 White Paper, the Hardened Network Army initiative and the Enhanced Land Force initiative are the basis for the expansion and are discussed in the following paragraphs.

1. Defence 2000 White Paper

At the start of the millennium, the government released the "Defence 2000: Our Future Force" White Paper, which was essentially the commencement of the current expansion. The White Paper directed the Army to grow so that it could "sustain a brigade on operations for extended periods, and at the same time maintain at least a battalion group available for deployment elsewhere" (Commonwealth of Australia, 2000). The Army's growth was to be a significant proportion of the 2,500 personnel in the ADF's planned increase by the year 2010.

At the time of the White Paper release, separation rates were up several percent from the early 1990s. The ADF had also failed to meet its recruiting goals by 25% in the previous year, a shortfall of 1,300 people (Commonwealth of Australia, 2000). Despite the issues with both recruiting and retention at the time, the goal of 54,000 personnel in the ADF by the year 2010 seemed within reach, particularly because the problem had been highlighted early and significant reform in the area had been a feature of the White Paper.

2. Hardened and Networked Army (HNA)

“Australia’s National Security – A Defence Update 2005” outlined the new strategic direction for the ADF as a result of the changing global environment. The Hardened and Networked Army (HNA) was a concept released in December 2005, designed to meet the requirements of the 2000 White Paper and the 2005 Update. In essence, it involves creating a larger and more capable Army able to fight in a more complex and lethal battlefield. Additional and/or improved military hardware are progressively being introduced into the Army to enhance the force’s firepower, protection, mobility and communication capabilities. In terms of personnel strength, HNA required an increase of 1,485 soldiers by 2015, representing an increase of approximately 5% over December 2005’s strength (Department of Defence, 2006a).

3. Enhanced Land Force (ELF)

In addition to the increase of personnel as part of HNA, the government announced the ELF initiative in August 2006. The ELF’s main purpose is to provide two additional infantry battalions with supporting arms: in total, approx 2,600 people. The reason for the additional battalions was so that Australia could continue to assist in regional stability operations with northern neighbors without detriment to other global commitments.

E. ARMY ENVIRONMENT

1. Operational Tempo

The Australian Army is now maintaining an operational tempo not seen since World War II (Chief of Army, 2006). The contributions arise in several forms, including participation in the Global War on Terrorism, peace keeping or enforcement, security operations for events such as the 2007 Asia Pacific Economic Cooperation (APEC) forum, and humanitarian assistance following natural disasters. While the Australian Army has been very successful in recent operations, the high tempo can take its toll on both the serving members and their families.

2. Manning Trends

When the Australian Government announced in its 2000 Defence White Paper that the ADF would grow by 2,500 personnel over a decade, the net flow of personnel in the Army—like the entire ADF—was negative. Forecasts released in the White Paper suggested that if current recruiting and retention rates remained until 2010, the ADF would be 12,000 below the target figure of 54,000 (Commonwealth of Australia, 2000). The requirements of HNA and ELF have now magnified the manning deficiency that faces the Army in particular.

In the late 1990s and early 2000s, Army separation rates hovered around 13% (see Figure 2). By historical standards, this was high but not abnormally high. More significant was the inflow and outflow of personnel in Figure 3, showing the negative flow of personnel into the Army in the late 90s, up until the release of the White Paper.

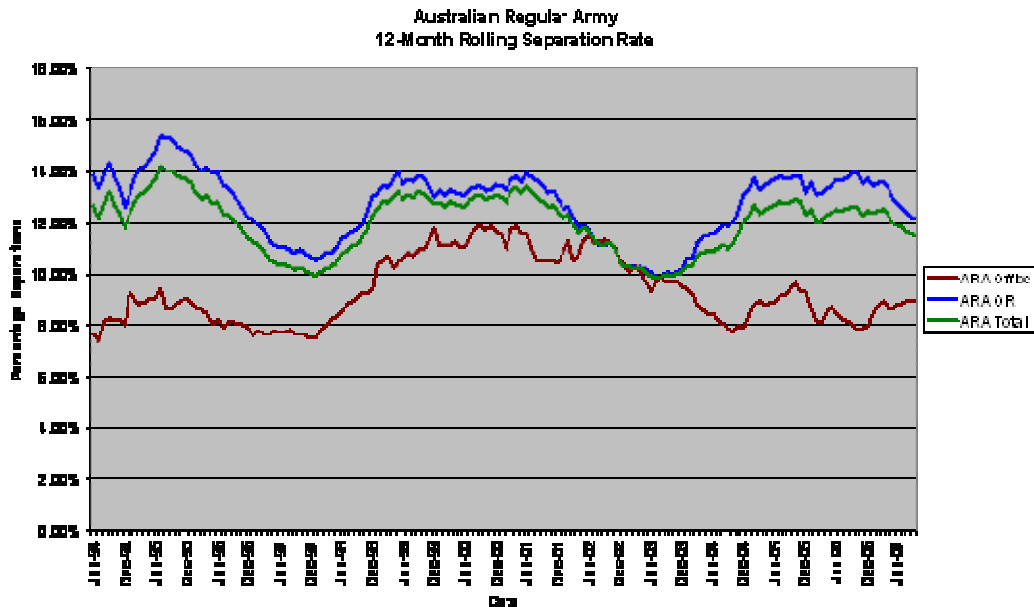


Figure 2. Australian Regular Army 12-month rolling separation rates
[From Directorate of Workforce Modeling and Analysis – Army (DWFMA(A))]

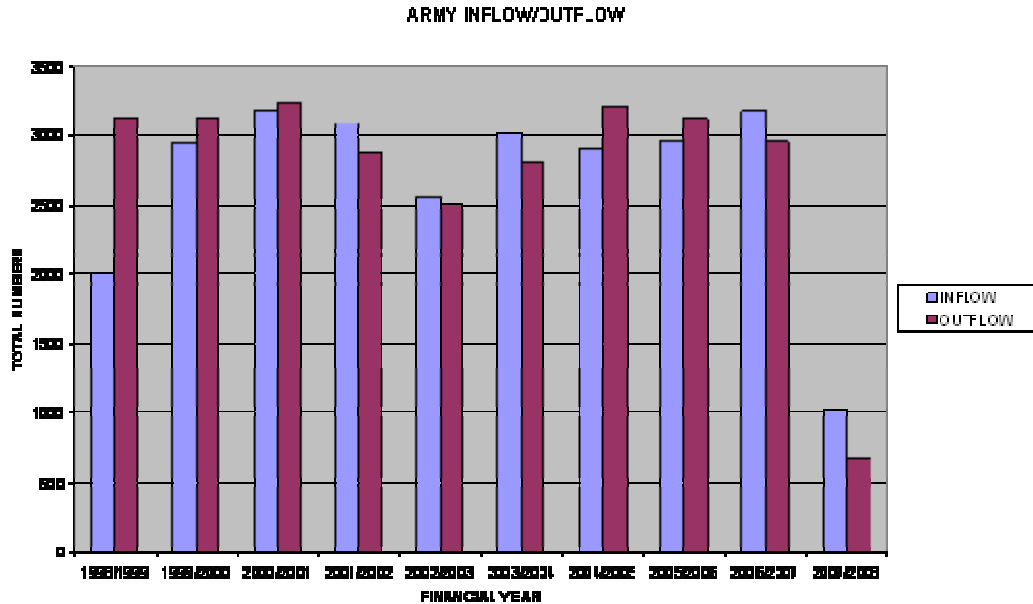


Figure 3. Army inflow/outflow of personnel [From DWFMA(A) and Defence Annual Reviews]

An important factor affecting the negative flow of personnel in this period was the strength of the Australian economy. It was therefore understood that the Army needed to make employment conditions more favorable to be competitive in the labor market. Remuneration, locational stability and employment condition reform were necessary to meet future goals. Several initiatives were introduced as a result of the White Paper, and for the next three years there was a positive flow into the Army.

It was in financial years 04/05 and 05/06 that manning again declined. Separation rates rose to almost the levels of the late 90s/early 2000s and recruiting could not compensate, let alone grow the force. There were several contributing factors, including the economy continuing to strengthen and the increasing operational tempo taking its toll on families. Critics claimed that the Army had not done enough to improve financial and non-financial conditions to recruit and retain the necessary force.

The high separation rate (by historical standards) in recent times can be attributed to several things. The 2006 Defence Attitude Survey highlighted several possibilities;

significantly that satisfaction with salaries had declined for four consecutive years (Department of Defence, 2007a). However, pay is not the only issue responsible for high separation levels. The regular posting cycle affecting family stability, and an inefficient career management structure, are both reasons that tend to appear frequently in literature on ADF retention in the past 15 years.

F. RETENTION FROM AN INVESTMENT POINT OF VIEW

Like most western militaries, the ADF funds much of the training and education necessary to enable a member to do their job. When a member leaves, they take with them their experience and the benefits of any job-specific training and education provided—this is not dissimilar to what occurs in a civilian organization. The resulting gap can be dealt with in two ways, either by requiring more work out of the existing staff or by recruiting a replacement.

However, a replacement can not be recruited immediately when an experienced soldier leaves the force; instead, it may take many years to develop a person to the same standard. As a general rule, the ADF “grows” its own hierarchy where all recruited personnel go through either recruit or officer training and begin at the lowest rank. The 2000 White Paper explains that many are leaving at the point where they have the most to contribute.

Ideally, the Army would like a positive return on investment (ROI) for the education and training provided to each individual. To do this, the Army employs two basic strategies:

1. Initial Minimum Period of Service (IMPS)

The IMPS is the obligated period for which a soldier enlists. Different occupations within the Army require different IMPS, but in general, non-technical jobs require a four-year IMPS while technical jobs require six years.

2. Return of Service Obligation (ROSO)

A ROSO is similar to an IMPS and is established for educational courses or “general training” that has value to the service member outside of the ADF. The basic rule for ROSO is for the member to provide the same number of years to the service as in training plus one additional year. For example, four years of officer training which includes an undergraduate degree attracts a five-year ROSO.

IMPS and ROSO requirements do not take into account the exact value of an individual training course, instead taking a simplified view with the same rules for everybody. Depending on the value of the course, Defence may or may not get a positive ROI from the service member.

It makes sense that the longer an individual serves, the more likely it is that the ADF will achieve a positive ROI for the education or training provided. This leads to a more senior and more experienced force, creating efficiencies for the organization. While an aging force can lead to additional costs in terms of housing and medical expenses, the benefits include lower recruiting and training costs.

G. CURRENT SITUATION

The problem of growing the Army is more than a recruiting issue. When creating two new battalions to meet the requirements of ELF, the battalion hierarchical structure essentially dictates the growth strategy. Under the right conditions, many of the positions at the rank of Private, Lance Corporal and Lieutenant could be recruited; however, it is not so easy at other rank levels within the hierarchy. As the Chief of Army, Lieutenant General Leahy said in March 2007 (Commonwealth of Australia, 2007c):

I need Corporals, Sergeants, Captains and Majors to make two new infantry battalions. I cannot recruit them; I can only make them, and they take between six and...12 years to make.

Retention of personnel at those ranks has therefore become a high priority.

As mentioned previously, the retention problem is not new to the Army. The literature reveals numerous reviews into the problem, including the Glenn review in

1995, five years before announcement of ADF growth in the 2000 White Paper. Retention focus pre-2000 was more about cost and efficiency, where now the focus is in terms of force expansion. While the focus may have been historically different, the principals to achieve lower separation remain the same, and many of the recommendations of earlier reviews have taken (or are still taking) time to implement.

Jans and Frazer-Jans (2006) conducted a study into retention strategies for General Service Officers. They found that 39% of officers surveyed indicated their intention to leave the army in the next three years. They also showed that the career commitment of junior officers had fallen over the ten years to 2005: 38% of junior officers (LT and CAPT) intend to separate within three years compared to 30% in 1995. While surveyed intentions generally overestimate actual behavior, Jans and Frazer-Jans noted a high correlation between actual current separation rates and separation intentions.

Jans and Frazer Jans (2006) make several recommendations to address the officer-retention problem. One of the key recommendations was to use initiatives that provide a “short, sharp shock” to separation rates to get the manning back under control before more robust and sustainable measures are put in place. In effect, this strategy was a means of buying time to develop longer term retention initiatives. It is also a means of reducing the effects of a downward spiral: as people leave, more work is required of the existing personnel, which could lead to lower morale and further separations.

In 2006, soon after Jans and Frazer-Jans completed their study, the “Henry Report” was completed. The Henry Report was another review of strategies for improved recruiting and retention in the ADF. While the outcomes of this review are unknown, it is worth noting that much of the recent government spending on recruiting and retention followed closely after the Henry Report was finalized.

H. CURRENT BONUSES AND INCENTIVES

In December 2006, the Australian Government announced a \$1.016 billion (AUD) package to overhaul the ADF recruiting and retention incentives. They further added to this in the 2007/08 Budget with an additional \$2.071 billion over 10 years (Department of Defence, 2007b).

As part of the allocated funds, the Army announced its “Army Expansion Rank Retention Bonus” (AERRB). In short, the bonus offers targeted financial incentives to personnel who hold high-value skills and/or experience in certain ranks necessary for expanding the Army. All retention bonuses announced at the time were “short-term measure(s) until other major career and remuneration reforms are in place” (Department of Defence 2006b). The next section looks more closely at the AERRB targeted at personnel at the rank of Corporal, Sergeant, Captain and Major.

I. THE AERRB

Retention bonuses in the Australian Army have not commonly been used. In recent years, only selected occupation categories received bonuses when retention rates were critically low. The introduction of more widespread bonuses, as recently occurred in March 2007, was new territory for the Australian Army. Unlike the United States Military, which has used reenlistment bonuses for approximately 40 years, Australia has limited historical data on bonus amounts that have achieved certain retention levels.

The AERRB was designed to encourage experienced Corporals, Sergeants, Captains and Majors to commit to four more years of service beyond the major separation hurdle of the first two to three years in rank (Business Case for AERRB, n.d.). To be eligible for the bonuses, a Corporal or Sergeant must have served two years in rank, and a Captain or Major must have served three years in rank, thereby applying the bonus at the critical separation point. The two components of the scheme are:

1. Retention Bonus

\$10,000 AUD paid up front for a commitment of an additional year of service.

2. Completion Bonus

\$30,000 AUD paid at the end of an additional three years following the period served for the retention bonus.

This author was unable to uncover the connection between desired retention and the AERRB that effectively pays \$10,000 p.a. for four years. It is not known whether the Army used the limited historical data it holds on previous retention bonuses and survey

data, or if data from another country (such as the United States) was used to estimate the necessary bonus. Whichever the case, this author believes either method would be inaccurate to judge the appropriate bonus for a desired level of retention. The lack of appropriate data (as the AERRB is the first of its kind) would have essentially forced the Army to make a leap of faith in determining its rate.

J. THE PROBLEM WITH USING RETENTION BONUSES IN AUSTRALIA

The fact that Australia has a limited history with retention bonuses means there is insufficient data available to provide meaningful analyses to predict retention levels achievable with certain bonuses. Inaccuracies in the necessary bonus level could be costly to the Army in either financial or manning terms. Almost 5,000 serving members were offered the AERRB in March 2007. If, hypothetically, \$9,000 would have retained the necessary people, the Army could have paid \$5 million (AUD) too much. On the other hand, if the \$10,000 offered was slightly too low, insufficient people would be retained and the manning gap would grow further, creating a larger retention problem in subsequent years. This might lead the Army to offer higher future bonuses, which teaches service members to wait for the higher second offer in the future, thereby costing the Army more money.

This appears to be the problem with offering any set bonus; there is no real way of knowing the effectiveness of this bonus until it is too late. Important questions that need to be considered before implementing a bonus are:

- Is it enough to entice the total number of personnel needed? or
- Is it too much? Will valuable resources be wasted on retaining more personnel than the service actually needs?
- Are quality personnel being retained?

These questions are not easily answered, and it is for this reason that this study was conducted. This study is important as the recently offered bonuses may have cost the government more than necessary, or conversely may not have been sufficient to achieve the desired effect. The use of an auction process may be a cost effective strategy to retain the right number of personnel.

K. EFFECTIVENESS OF AERRB

It is too soon to analyze the effectiveness of the AERRB (i.e., did it achieve its desired retention levels or was it overkill resulting in resource wastage?). The only real means of predicting its effect is to analyze similar bonuses in other countries. The United States, which has used such bonuses, provides an ideal learning platform.

L. MAKING COMPARISONS TO THE U.S. MILITARY'S BONUS SYSTEM

Learning from another country's use of retention bonuses is not as simple as it sounds. When attempting to apply logic from one country to another, policy differences complicate the process. One of the major differences is the enlistment contract system of the U.S. compared with open ended engagements in Australia.

Australian service personnel who have completed their initial obligation are generally on open ended contracts. Additionally, Australia does not employ an "up or out" system where people uncompetitive for promotion are required to leave the service. This means that unless a member is serving an IMPS or ROSO, they can discharge from the service when they want, or continue to serve as long as they desire. There are some obvious exceptions to this, including discharges for poor performance or disciplinary reasons, and the mandatory retirement age of 60.

The benefit of an open ended engagement system is that it appeals more to "Generation Y" who have now become the Army's recruiting focus. However, the disadvantage of an open ended engagement system comes when trying to predict the number of personnel retained when applying a retention bonus. With the AERRB in Australia, service members wanting to retain the flexibility to resign when they want could decline the bonus offer but continue to serve. Therefore, any models used to find a bonus amount that gives a necessary retention level are likely to underestimate the true retention of personnel.

M. CHAPTER SUMMARY

This chapter has introduced the retention problem that faces the Australian Army and the environment in which the problem must be addressed. The Army has made initial steps to address the retention problem, but it is too early to tell if these steps were effective. Without doubt, the Army is learning from its own experience with its first use of wide spread retention bonuses; however, there are other lessons that can be learned from the experience of foreign militaries, and an analysis of the U.S. bonus system will follow in the next chapter.

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III. EFFECTIVENESS OF THE U.S. MILITARY RETENTION BONUS

A. INTRODUCTION

As discussed in the previous chapter, the Australian Army is relatively new to the concept of retention bonuses. In a time where increased retention has become a necessity and using retention bonuses a reality, it is important to learn from other militaries that have greater experience in this area. The U.S. Military, having used retention bonuses for approximately 40 years, provides an ideal learning platform. While policy differences do not allow a U.S. bonus template to be directly applied to the Australian Army, there are still important lessons to be learned by studying both the problems and successes of the U.S. program.

This chapter looks at the Selective Reenlistment Bonus (SRB) used in all four services of the U.S. Military. It starts by explaining the SRB, its use and its history. It then looks at the effectiveness of the SRB compared to other alternatives and the effectiveness of how it is applied.

B. THE SELECTIVE REENLISTMENT BONUS (SRB)

As the U.S. Military does not have open ended engagements for their enlisted personnel, those wishing to continue to serve beyond their contract must reenlist for another fixed period. The problem is that often the number and skill mix of those wishing to reenlist does not meet the needs of the individual service.

The most commonly used tool to increase reenlistments to meet the service need is the Selective Reenlistment Bonus (SRB). The SRB is a cash incentive paid to enlisted members to encourage reenlistment. It is designed to encourage retention of those who have the skills necessary to meet the services' ongoing needs. Historically, the SRB program has been the U.S. Navy's most cost effective tool in targeting retention and increasing the numbers of experienced personnel (Cylke, Hogan & Mackin, n.d.).

As the Chief of Naval Personnel, Vice Admiral John C. Harvey, Jr. stated in November 2006:

The goal of SRB is to ensure our mission readiness by ensuring sailors with the right skill mix are available to the fleet...The bonuses are an extremely flexible, positive and ultimately effective tool for ensuring sailors reenlist...where we need them most.

C. HISTORY OF THE SRB

The U.S. Military first started using reenlistment bonuses in 1965 to combat problems in first term retention and career manning. In 1974, the program was adjusted and was renamed the Selective Reenlistment Bonus. While the payment method and various administrative processes have evolved since 1974, the purpose of increasing reenlistments where there would otherwise be shortages remains the same. Hattiangadi, Ackerman, Kimble and Quester (2004) highlight that two areas are at risk of shortages: those technical jobs where members have skills highly valued in the civilian economy (and consequently have better civilian alternatives), and those jobs that are arduous.

While many non-monetary conditions effect reenlistment decisions, higher levels of monetary compensation relative to civilian industry are associated with higher levels of retention. Theoretically, compensation increases in the form of a bonus and a pay raise essentially have the same effect; however, the U.S. Military generally uses SRBs because of their relative flexibility. Asch et al. (2002) explain the flexible nature of the SRB as the ability to “respond to temporary changes in reenlistment rates, such as those resulting from cyclical changes in the civilian economy that alters the flow of personnel to the mid career and senior ranks.”

The SRB has become the primary tool for affecting reenlistment rates (Hattiangadi et al., 2004). This is due to both its flexibility and cost effectiveness relative to other incentives, which will be discussed later in this chapter. The importance the military places on the SRB can not be understated, and is reflected by the significant

growth in the SRB budget over the last decade, where there have been increases in financial sums offered as well as a broadening of the number of skill sets eligible for the bonuses.

D. WHO IS OFFERED THE SRB AND HOW IS IT CALCULATED?

As the name suggests, not all service members are eligible for the SRB at the end of their contract. To be eligible, an individual must possess one of the skill sets that the service needs. Natural reenlistment rates for that particular skill must be lower than needed by the service for an SRB to be offered. Additionally, the individual must meet certain eligibility criteria, be recommended for reenlistment, and sign on for at least another three years of service.

The formula for the dollar value of the SRB is:

$$\text{\$ SRB} = \text{Monthly Base Pay} \times \text{Additional Years of Commitment} \times \text{SRB Multiple}$$

The SRB multiple could conceivably be any positive number; however, the U.S. Department of Defense permits multiples between 0.5 and 15 (Hattiangadi et al., 2004). In practice, multiples above 6 are rarely used. A multiple is chosen dependent on the necessary retention level. Regression models using historical data estimate the reenlistment percentages achievable with certain SRB multiples. Skill areas with sufficiently high natural retention may have a SRB multiple of 0, implying no bonus is offered for additional service. For areas where retention is low due to more lucrative civilian opportunities, a multiple of 5 or 6 may be needed, which results in a large bonus for those willing to continue serving.

The SRB multiples are constantly monitored and adjusted. The need for specific skills, both current and future, is the primary driver of SRB levels. This need changes as a result of many factors, including attrition, attitudes toward the service, economic conditions, mission changes and advancement in technology. Prioritization of skill sets is important, because budgetary constraints do not always allow all areas to be offered the

necessary SRB multiple to achieve manning goals. The juggle between budget and priority often results in bonus levels changing, either up or down, within a particular fiscal year.

E. EFFECTIVENESS OF SRB COMPARED TO OTHER INCENTIVES

Theoretically an increase in monetary compensation, be it through basic pay or a bonus, yields higher retention rates. Higher military/civilian pay ratios have consistently been proven to increase military retention, holding other factors constant (such as economic conditions). While the overall retention outcomes using pay and bonus options are similar, the overall cost effectiveness of the two methods is very different due to the ways in which they are applied.

Base pay levels across all four services of the U.S. Military are linked. A member's base pay is determined by rank and time in the service. This means, for example, that a Sergeant in the Army who has six years experience collects the same base pay as a naval Petty Officer Second Class (equivalent to an Army Sergeant) with the same seniority, despite the fact they have vastly different roles.

Uniformity in base pay levels across the services makes pay raises complex. Raising pay to address a retention problem within one area of a service results in a pay raise for all skill sets across the four services. While a simplistic example, it is easy to see how a pay raise to improve retention in one area is likely to result in excessive retention in another where it may not be necessary. This results in unnecessary resource wastage, making this an expensive option. An across the board pay raise could only be cost effective in increasing reenlistments where retention is low across the entire force.

Military provided housing is an incentive often thought to assist retention; however, as Hansen and Koopman (2005) point out, "service members [on average] value housing less than it costs the military to provide it." This means that the provision of military housing may not be cost effective, making basic pay, despite its shortfalls discussed above, a superior incentive to housing. Additionally, like basic pay, military housing is provided to all service members at a standard commensurate with their rank and family status. This means that improvements in housing standards are likely to have

an impact on retention across the force, not just where the manning shortages exist. Military housing is therefore a very expensive retention tool.

The SRB as a retention tool has advantages over both basic pay and housing in terms of its flexibility. If a certain area has manning shortages as result of poor reenlistment, the SRB can be directed at that skill with minimal interference to other areas. Budgets for SRBs are allocated to each service, which means that the approval process is far simpler than Defense-wide base pay increases or housing improvements. Finally, the fact that SRBs are targeted at areas with insufficient reenlistments makes this a more cost effective use of resources. For this reason, the services consider the SRB to be more appropriate than other retention incentive methods.

F. RECRUITMENT VS. RETENTION

Several studies have looked at the SRB return on investment in the U.S. Navy; one study was completed by Cylke et al. (n.d.) and another by Hansen and Wenger (2003). These studies center on the idea that high retention levels reduce the enlistment necessary, which results in fewer training and recruitment expenses.

Cylke et al. did a cost benefit analysis of two strategies:

- Low SRB, which resulted in lower retention rate and a greater number of recruits and trainees needed.
- High SRB, which resulted in higher retention and therefore lower numbers of recruits and trainees needed.

In the cost benefit analysis, the benefits included cost avoidance (avoided training and recruiting costs) and the costs were the actual SRB payments. They found that whether the SRB was beneficial depends on the career field. For example, the cost of recruiting and training sailors is very high in the IT field; therefore, it is more cost effective to retain more service members using the SRB. But in other trades, where recruiting and training costs are lower, it is more cost effective to recruit more, with the expectation of losing a greater percentage but still achieving long-term manning goals.

Hansen and Wenger (2003) wanted to establish whether the U.S. Navy, through its use of SRBs, was retaining too many people to be cost effective. A general consensus

existed that greater retention was better for the service, as it meant less recruiting and training costs and a more experienced and productive workforce. The study showed that this idea is not necessarily true. They found that it was beneficial to increase retention (and therefore SRB levels) in only a small number of skills. However, in the majority of skills, they found that the Navy could make significant savings by reducing the SRB level, accepting lower retention and increasing recruiting to compensate for the lower retention levels.

The determination from these two studies is that the SRB is not always the answer to manning deficiencies. There is a point up to which retention (and the associated bonuses with that retention) is cost effective, but beyond this the service would be better off recruiting and training more people.

G. LUMP SUM VERSUS ANNUAL INSTALLMENT SRB

As part of his thesis while studying at the Naval Postgraduate School, Ross (2000) looked at the then Marine Corps policy of paying SRBs in installments. He concluded that “zone A¹ first-term Marine retention will increase between 6.8 % and 11.7 % if the SRB payments were made in lump sum.” His findings centered on the fact that individual personal discount rates (PDR) are higher than the government discount rate.

Hattiangadi et al. (2004) explain the PDR:

The personal discount rate answers the question: how much would my dollar have to be reduced today so that I am indifferent between receiving that reduced amount today and receiving a dollar one year from now? The reduction (in percentage terms) is the personal discount rate.

A high discount rate is associated with a present-oriented person (Ehrenberg & Smith, 2006); that is, they have a preference for current consumption rather than future consumption. Ross’ research highlighted that there are many influences on a PDR, but that young enlisted males were likely to have high discount rates. He observed that young enlisted men who have loans for new cars prefer current consumption (the new

¹ Zone A - reenlistments occurring between 21 months and 6 years of service

car) despite the fact that the loan will cost more than the present value of the car in the long run.

When an individual's PRD is higher than the federal government's discount rate, both the service and the individual benefit from making SRB payments up front. For the individual, the up front payment is valued more highly; for the service, the up front payment is more cost effective, meaning that the same level of retention can be achieved with smaller bonuses.

The USMC made the switch to paying SRBs in lump sums in fiscal year 2001. Even though the literature shows that lump sum SRBs have a larger effect on reenlistments than annual installments, the other services continue paying 50% of the SRB upfront and 50% in anniversary payments. In fiscal year 2003, it is estimated that the former system of anniversary payments in the Marine Corps would have cost at least \$8 million more (representing 30% of the zone A SRB budget) to achieve the same level of zone A retention (Hattiangadi et al., 2004).

H. COULD BE MORE EFFICIENT

One of the drawbacks of the SRB process noted by Hansen and Koopman (2005) is that the service can not identify those who would have reenlisted without the presence of the bonus. It is for this reason that bonuses are paid equitably to all service members in an eligible category. The result is that many are "over paid," as the enticement is above the minimum they would have accepted to reenlist. This reduces the cost effectiveness of the bonus, particularly when the retention level of the skill was already high and the service wanted to raise it further.

North (1994) calculated the Marine Corps' costs of securing higher reenlistment levels using zone A SRBs. He demonstrated that while reenlistment rates increase with higher SRB multiples, the cost of each additional reenlistment also increases. This is because Marines who are willing to reenlist with a lower SRB are paid additional money to make the bonus equitable.

Figure 4 demonstrates the idea. A simplistic reenlistment supply curve is plotted, indicating the various levels of reenlistment achievable (horizontal axis) at given levels of compensation (vertical axis). At a compensation level of C_1 where no bonus is paid, R_1 people are willing to supply labor by reenlisting. If the service wished to increase reenlistments to R_2 , it would not be possible without increasing the compensation level. The bonus in the graph takes the total level of compensation to C_2 .

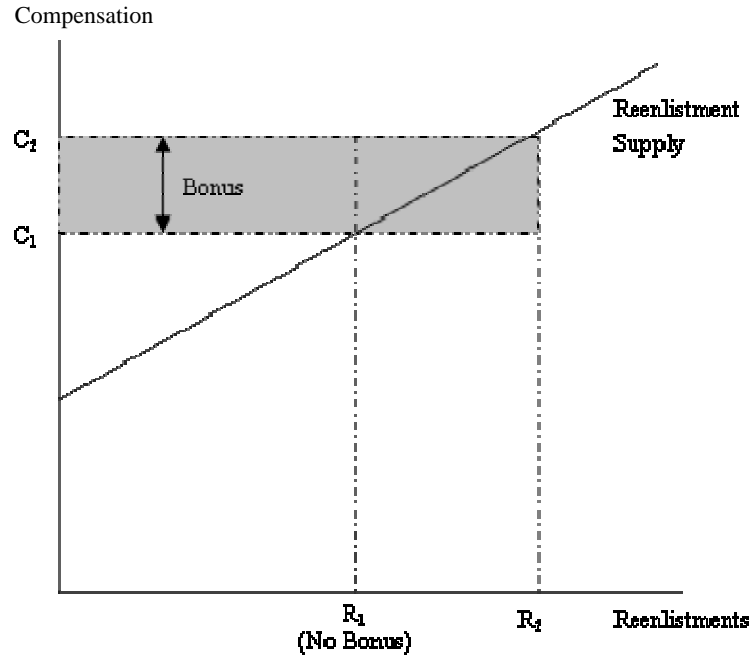


Figure 4. Compensation at different reenlistment levels [After Figure 12 of Hattiangadi et al., 2004]

Instead of the bonus being paid to just those additional people enticed to reenlist, the bonus is paid to all those who reenlist. The shaded area below the reenlistment supply line in Figure 4 represents the additional payments required to increase retention from R_1 to R_2 ; the shaded area above the reenlistment supply line is the additional payment required because all service members receive the same bonus. To ensure there is equity in compensation across a given skill, the cost of inducing the additional reenlistments by the bonus is the entire shaded area.

The costs of inducing another reenlistment are higher when reenlistment rates (without a bonus) are already high. Graphically, this is demonstrated by the shaded area to the left of R1 (essentially the resources wasted); this area grows faster as there are more people in this group.

I. FLOW ON EFFECT IN LATER YEARS

Offering an SRB as a one-off measure to increase reenlistments does not necessarily fix a long-term retention problem in a particular area. As Goldberg (2001) and Hansen and Koopman (2005) point out, those retained at the first decision point because of the bonus have a relatively low preference for military life since they would have left the service without the bonus. Therefore, in the absence of a bonus, reenlistment rates are likely to be worse at subsequent decision points than historical data suggests. As these cohorts move through the system, the retention problem is likely to shift to a different rank and seniority level unless further bonuses are offered. Once started, there is no easy solution to ceasing reenlistment bonuses without accepting future manning shortages.

J. LACK OF PRECISENESS OF THE SRB

The SRB multiple chosen is a vital element of the SRB payment. The multiples are restricted to half numbers; however, the difference between the dollar value of an SRB multiple of 3 and 3.5, for example, could be quite large. Consider a member who has a base pay of \$2,000 per month and wishes to reenlist for 4 more years:

$$\text{Multiple of 3:} \quad \$ \text{ SRB} = \$2,000 \times \text{multiple } 3 \times 3 \text{ years} = \$24,000$$

$$\text{Multiple of 3.5} \quad \$ \text{ SRB} = \$2,000 \times \text{multiple } 3.5 \times 3 \text{ years} = \$28,000$$

This \$4,000 gap is far from insignificant. A number of people will likely change their reenlistment decision for this sum of money. Statistical models can predict the necessary multiple; however, they can never be 100% accurate. Suppose 1,000 soldiers chose to reenlist for a multiple of 3.5 when a multiple of 3 would have been sufficient to retain the 900 service members required. The resource wastage in this example is \$6.4

million (\$4,000 overpayment to each of the 900 targeted reenlistments plus \$28,000 to each of the 100 service members over the target), not to mention the additional costs of salary, housing and other costs associated with additional soldiers. On the other hand, an incorrectly predicted SRB multiple could leave the service short of many needed soldiers.

K. SUMMARY

The SRB system has proven to be a highly effective reenlistment tool in the U.S. Military. The system, although modified, has existed for more than 40 years and has been used increasingly in recent years. There is little doubt that it is the most effective tool for increasing retention within the U.S. Military.

The time of payment has a significant effect on the retention effect of a bonus, a fact that the Marine Corps has recognized. The Australian Army could benefit from this knowledge, as its completion bonus component of the AERRB is paid at the end of the service term rather than as an upfront payment for a set contract length. Australia's deferred payment is less effective than the U.S. services who continue paying yearly installments of 50% of the bonus.

Despite its cost effectiveness compared to other retention strategies, there are still inefficiencies with the SRB. Many people are paid to reenlist who would have done so willingly without the bonus or with a smaller bonus. Additionally, the SRB multiple creates a several thousand dollar gap between even the smallest multiple increments, meaning that the bonus could be either excessively costly or miss the intended retention target. It is therefore not just the Australian Army that needs a more accurate method of determining the level of retention bonus.

The next chapter looks at an alternative method of establishing a bonus amount. The accuracy it provides in establishing a monetary retention bonus could have benefits to both the Australian and U.S. militaries.

IV. AUCTION THEORY

A. INTRODUCTION

Recent theses at the Naval Postgraduate School have considered using auctions to administer the Selective Reenlistment Bonus (SRB) in the United States Navy. Filip (2006), Norton (2007) and Bock (2007) all looked at the use of a sealed-bid, second-price auction as a more cost effective means than the extant system. This chapter will explore the auction concept in further detail, first discussing the theory and the various auction processes.

B. WHAT IS AN AUCTION?

An auction is a system of selling goods or services, where the price is set by bids placed by the market participants. A variety of auctions are used in the market place and these are discussed in this chapter. Auctions are used extensively in the product market but rarely used in the labor market.

As previously outlined, this thesis considers applying auctions to military retention bonuses—that is, payments for an agreement to provide additional service. To do so, this chapter explains some of the different auction designs, including the English, Dutch, and the first and second price sealed-bid auction. When considering these auction mechanisms, it is of particular interest as to how they could be applied in a closed labor market, specifically for retention bonuses offered to Army personnel for a set period of service. Therefore, the second part of the chapter focuses on the ideal auction for determining retention bonus levels and how theoretically valuable the outcome might be.

C. FORWARD AND REVERSE AUCTIONS

Auctions can be classified as either forward or reverse. The number of buyers and sellers determines the designation.

1. Forward

A forward auction is normal in a product market where there is a single seller and multiple people hoping to buy the product. The winner in this type of auction is the person willing to pay the seller the highest price.

2. Reverse

A reverse auction is the opposite; there is one buyer and multiple sellers competing to provide the item. The winner in a reverse auction is the person willing to provide the item at the lowest cost to the buyer. This is the type of auction often used when companies are vying to win a government contract to provide a service.

When determining whether a forward or reverse auction is applicable to military retention bonuses, it is important to consider that militaries operate in what is essentially a closed labor market. The “sellers” are the pool of eligible serving personnel willing to continue to serve at the right price. While there are other possible buyers of former soldiers (civilian industry), there is arguably only one buyer in the market to employ soldiers to be soldiers. With one buyer and multiple sellers, it is clear from the earlier definition that a reverse auction is appropriate for this internal labor market. The winning bidders will be those willing to commit to a further period of service at the lowest costs.

The next section describes different available auction mechanisms. Although a reverse auction is most applicable to this study, the auctions below are described in terms of a forward auction in the product market for simplicity. Later, the reverse auction application in the labor market will be explored in further detail.

D. AUCTION DESIGNS

1. English Auction

An English auction is the design with which people are usually most familiar. It is commonly used in Australia in many circumstances, including the sale of real estate, livestock, and motor vehicles. In an English auction, the bidders interact directly with each other in stages (Campbell, 2006). Someone starts by bidding for the item; other

potential buyers can increase that bid by agreeing to a higher price proposed by the auctioneer. Individuals can each bid many times as the price for the item increases. The auction ends when there is only one potential buyer remaining and no one else is willing to raise the bid. The last person remaining wins the auction and pays the price of the winning bid for the product/service sold. There are several mediums through which an English auction can be conducted, including in person or online. Regardless of the medium, however, potential buyers always know the current highest bid as the auction progresses.

2. Dutch Auction

Dutch auctions originated in the Netherlands as a mechanism for selling flowers. Normally all prospective buyers are physically present at the auction. Unlike the English auction, which starts at a low price, the Dutch auction starts at a very high price. The price is then gradually lowered until a bidder declares they will take it. There is only one bid in this auction, and that is the first person to call out. The winner purchases the product/service for the price to which the auction has fallen. The Dutch auction has a “game” aspect to it; the bidder wants to bid as low as possible to maximize their gain; however, they must take into account the probability that competing buyers will bid as they wait for the price to fall further (Vickrey, 1961).

3. Sealed-Bid Auctions

The two auctions described above are both open auctions, which take place at a set time in a set place with all bidders represented and bids made openly. In contrast, sealed bid auctions may occur over a period of weeks or months and do not require potential buyers’ physical presence. In a sealed bid auction, potential buyers submit just one bid, which is normally done in writing. Potential buyers make their bid without knowing how competitors value the item or observing any competing bids. There are two types of sealed bid auctions:

a. First Price

This is the most common form of sealed-bid auction and is often referred to as a “silent auction.” Potential buyers submit written tenders and the winner is the highest bidder, paying the value of their bid for the product/service. As there is only one opportunity to bid, a potential buyer can not observe his/her competitors and potentially increase the bid, as in an English auction. Potential buyers are presented with the dilemma of trying to maximize individual gain by bidding low while still trying to win the auction with the highest bid. The optimal bidding strategy in this form of auction is to bid below the true maximum price the bidder is willing to pay.

b. Second Price

A second price auction, or “Vickrey auction” named after its founder William Vickrey, is less common than a first price auction. It is similar to a first price auction in that prospective buyers bid once without observing any bids from competing individuals. The difference is that the highest bidder wins the auction but pays the value of the second highest bid for the product/service. This aspect makes a second price auction “truth revealing;” that is, the optimum strategy for the buyer is to honestly bid the amount they value the good or service.

E. CHOICE OF MECHANISM

The choice of a specific auction mechanism depends on many factors. In terms of the financial return to the seller, each auction form yields on average the same result (McAfee & McMillan, 1987). The Dutch and first-price auctions have some commonalities, as do the English and second-price auctions. When comparing, the forward auction will be used.

Campbell (2006) demonstrates that a Dutch and a sealed-bid, first-price auction are outcome equivalent. Like the Dutch auction, when potential buyers bid in a first price auction they have essentially no knowledge of the value others place on the item. Buyers of a product in a sealed-bid, first-price auction want to bid as low as possible to maximize

their individual gain; however, bidding low increases the chance that a competing buyer will outbid them. The buyer in both auctions guesses the possible strategy of competing buyers so that they can win the auction while capturing the maximum possible individual gain. The effect is that potential buyers typically bid a price less than their true valuation (McAfee & McMillan, 1987).

Likewise, Campbell (2006) shows that the outcomes of an English and a Vickrey (sealed-bid, second-price) auction are equivalent in that the winner would pay the seller the same amount with either mechanism. In an English auction, the bidding stops at a level just higher than the second highest bidder, despite the fact that the winner would be willing to bid higher if necessary. The winner therefore pays an amount close to the second highest bidder, thereby making it equivalent to the Vickrey auction.

F. AUCTIONS POSSIBLE FOR MILITARY RETENTION BONUSES

Earlier, a reverse auction was illustrated to be appropriate for retention bonuses in the closed military labor market. The ideal design of the reverse auction, however, is not as obvious. The uniqueness of a military internal labor market means that certain auction designs would not be practical. The disbursement of service personnel throughout the world, either through training or operational commitments, essentially rules out a traditional English auction or a Dutch auction. Even using the Internet, the practicalities of having those eligible for a bonus online at the same time rules out an open auction.

From a practical point of view, a sealed bid auction would be more appropriate, be it a first or second price auction. The next section looks at both types in a reverse auction format appropriate to a military retention bonus. Before doing so, however, it is important to understand the concept of reservation value, as this will be discussed throughout this section.

Reservation Value. An individual facing the decision whether to continue to serve must consider their civilian and military opportunities in terms of preference and compensation. An individual who likes the service life may, for example, be prepared to receive \$5,000 less per annum than for equivalent work in civilian industry. On the other hand, a person who dislikes the service life may be prepared to leave the service even if

they were paying \$10,000 more than he could make in a civilian job. A reservation value combines both taste for continual service with opportunity cost of civilian employment, and gives it a dollar value. This reservation value represents the minimum sum of money for which, if paid by the military, the person would continue their military service. Each individual has a different reservation value, as they have different tastes and civilian opportunities.

1. First Price Auction

In a first price reverse auction, the winner is paid the value of their bid. Figure 5 is an example of how different soldiers may bid. If eight out of ten soldiers need to be retained in this first price auction, each would receive a different bonus ranging from \$2,500 to \$7,750. In theory, this auction is efficient, meaning that the service does not overcompensate those willing to stay in the service for lesser amounts of money. While this may appear attractive to the service, inequitable compensation for similarly skilled individuals may be difficult for the service member to digest, resulting in tension and morale problems in the ranks.

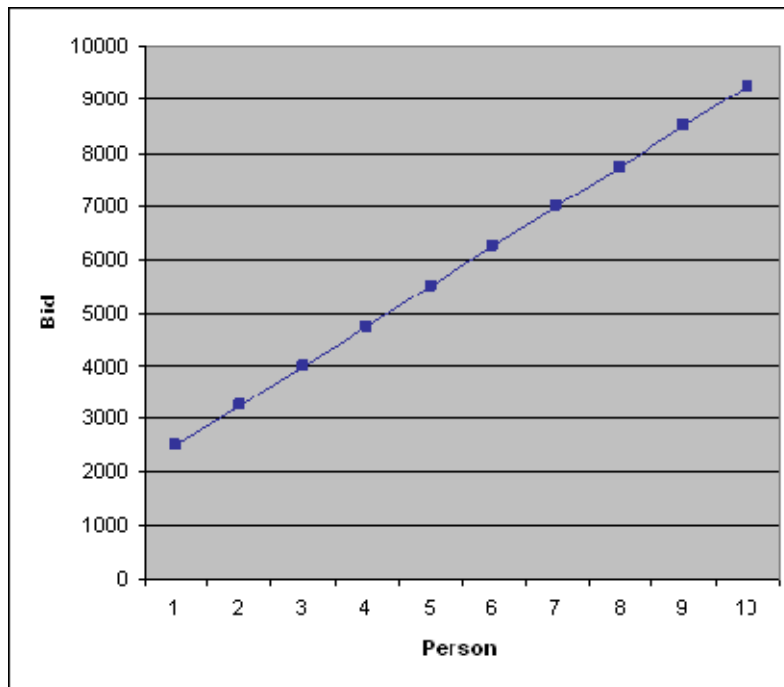


Figure 5. Example – possible bids for a Military Retention Bonus

It is also important to remember that the dominant strategy of the first price is to bid above the reservation value. In particular, each individual will try to estimate the bid submitted by the first rejected participant, hoping to keep their bid just below this value; this will enable them to win the auction while maximizing their surplus value. The bidding curve illustrated in Figure 5 (above) is therefore likely to be above that if members were bidding truthfully.

Figure 6 below shows a possible individual valuation (in pink) against the actual bid. The expectation is that bid inflation is larger for those who have a lower opportunity cost and smaller for participants closer to the margin where their bid may be rejected. The inability to control untruthful bidding means that the service can not learn about the true value that service members place on their service. .

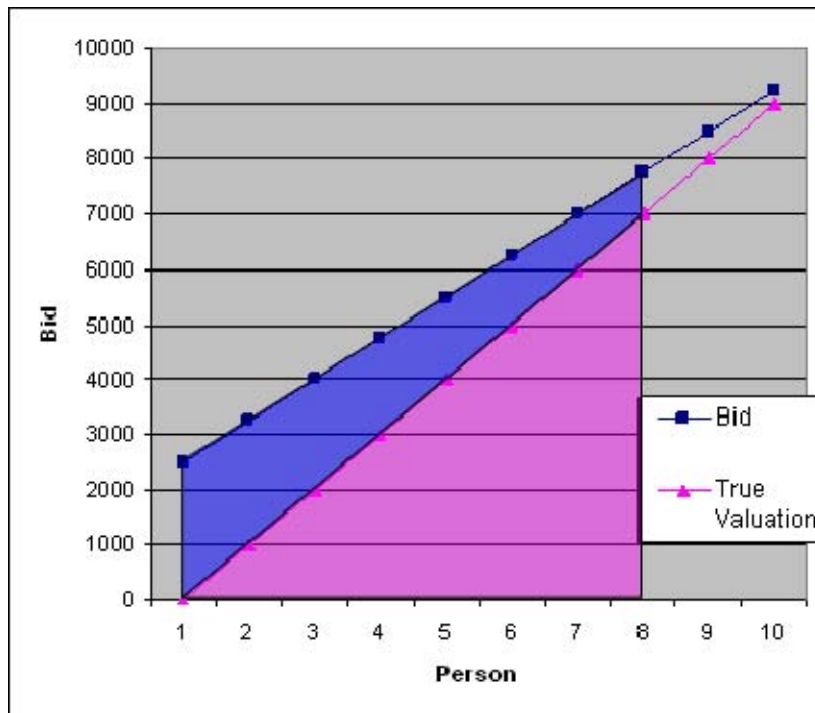


Figure 6. Example – possible bids for a Military Retention Bonus compared to an individuals true valuation

2. Second Price Auction

In a second price reverse auction, the winner has the lowest bid but is paid the amount equal to the first losing bid. Figure 7 presents an example of soldiers' bids for a retention bonus in a second price auction. Under the same circumstances as the previous example, bids should reflect individual reservation values.

Using the example depicted in Figure 7, if the Army wanted to retain eight soldiers, they would be paid \$8,000 (the value of the first losing bid being the ninth person), despite the fact that all eight soldiers were prepared to reenlist for less than this amount.

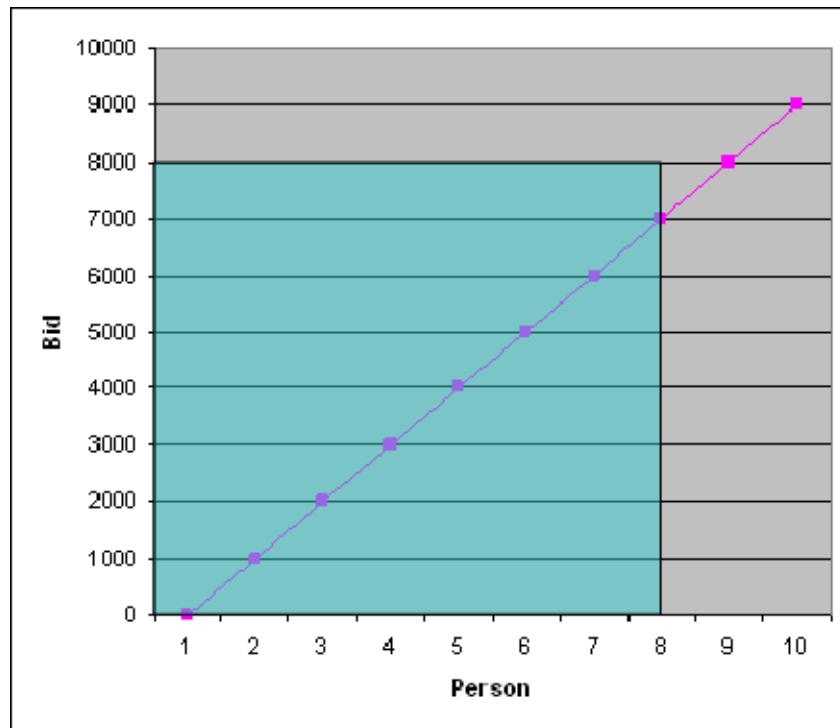


Figure 7. Example – cost of retaining eight soldiers in a second price auction, example in Figures 5 and 6

As mentioned earlier, the second price auction is “truth revealing;” there is no other bidding strategy that could make an individual better off than to bid the actual value that it is worth to them. If participants bid higher than their reservation value and are

among the winning bidders, the bonus paid does not increase, as they are paid the value of the first losing bid. A higher bid only increases the risk of walking away empty handed, when in truth the person would have accepted a lower bonus. There is no incentive to bidding below the reservation value because the individual might be retained when civilian opportunities would presumably make the person better off. If a person honestly bids their reservation value and is one of the winners, they would be paid more than their bid. Therefore, the best strategy to maximize an individual's expected gain is to bid their reservation value.

G. THE BEST AUCTION

It is likely that a first price auction would save the Army at least some money in retention bonuses. The savings come as a result of inequity in compensation among similarly skilled individuals. The problem with inequitable compensation is the likely morale backlash caused. It is extremely difficult to place a monetary figure on morale (or the loss thereof); however, a fighting force is usually ineffective without it. Therefore, it is extremely unlikely that a first-price auction would be viewed as acceptable from either the service or service-member's point of view.

Additionally, the bids in a first price auction are influenced by an individual's attitude toward risk. The risk-averse person may bid at or slightly above their reservation value, whereas another person with a high risk tolerance may bid much higher. The advantage of the second price auction is that attitude to risk should not influence a rational bid.

Finally, the truth revealing nature of a second price auction allows the service to gather information about an individual bidder's opportunity costs. An individual who has a high opportunity cost is likely to bid high, as they have more lucrative civilian opportunities should they leave the Army. An individual with fewer or lower paying civilian opportunities is more likely to want to stay in the Army and consequently bid lower. The data gathered, therefore, provides important information to the service on how its soldiers value their employment, which could be useful in subsequent pay reviews or in forecasting future bonus costs.

In summary, while a first price auction might be a cheaper option, it is unlikely to be viable. The second price auction offers several advantages which makes it a superior mechanism.

H. SECOND PRICE AUCTION LIMITATIONS

Despite the benefits offered by a second price auction, there are some specific limitations in their use with military retention bonuses. First, when manning shortages are so significant that all personnel in a given category need to be retained, the second price auction may not be as efficient as described earlier. If participants understand the extent of the manning shortage and suspect that all personnel need to be retained, they would lose the incentive to bid their true valuation. Further analysis would be necessary to establish whether a pre-determined bonus, using prediction techniques such as those currently used within the U.S. Military, would be cheaper to retain all personnel.

Collusion is also possible and likely to be a factor in auctions with few participants. The Australian Army, being a smaller organization than any of the U.S. services, is more likely to experience collusion. In small and highly specialized cohorts, where all personnel are stationed in the same location, an influential person could encourage participants to bid higher than their individual reservation value, again resulting in overpayments. An analysis as to the effect of collusion on bidding behavior is therefore important. If collusion was deemed to effect bidding behavior, the service would then need to weigh the possibility of overpayment to retain the right number of people against the possibility of retaining insufficient numbers with a cheaper pre-determined bonus.

Finally, introducing an auction process is likely to be difficult. A second price auction is not familiar to the average person, which makes training necessary before an auction is conducted. An online or electronic learning package would be appropriate, given that participants would be spread throughout the country. Although initially expensive to develop, the theory of the second price auction does not change, meaning that the training package should be a one-off expense.

I. CONCLUSION

A reverse auction is appropriate when conducting an auction to determine military retention bonuses. Practicalities of conducting the auction make either a first or second price sealed-bid auction the most feasible options. Of the two, the second price auction is the superior process due to its truth revealing nature and the fact a participant's risk tolerance does not affect their bid. Additionally, the data that could be gathered from the second price auction would be more valuable to the service than that of the first price. Although the process has its limitations and may not be appropriate in all circumstances, the benefits of using an auction in other cases is expected to return the Army significant cost savings over the current process of determining the necessary bonus amount. At the same time, an auction to determine a retention bonus returns the exact number of soldiers necessary, something that is highly unlikely with the extant process.

The next chapter introduces a labor market second-price auction experiment, designed to validate the theoretical concepts discussed.

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V. EXPERIMENTAL SETUP

A. INTRODUCTION

In September 2007, Dr. William Gates and Dr. Peter Coughlan of the U.S. Naval Postgraduate School (NPS) conducted experiments using a second-price sealed bid auction. The experiment was of a sequential and two-stage format, designed to be more efficient than just a single second price auction. Major William Norton, a former student of NPS explains the experimental setup of the auction in detail in his 2006 master's thesis. To assist explaining the experiment, Sections B-D of this chapter rely heavily on the content of Chapter V of Norton's thesis.

B. EXPERIMENTAL OVERVIEW

1. Purpose and Design

The goal of the experiment was to test whether an individual would reveal the true value they place on alternate employment. It isolated salary as the primary motivator for choice of employment between two generic firms, Firm A and Firm B. While “not military-specific by design, the experiment was intended to simulate the decisions a service-member would make under uncertain conditions” (Norton, 2006). The experiment had an Initial Salary Survey, which asks subjects for a salary bid for one year of employment, and a Second Salary Survey, where subjects make a salary bid for five years of employment. Only those successful in the initial survey progress to the second survey.

The two stage sequential design of the experiment acknowledges that employees in an organization may differ in their willingness to continue employment. Often, this difference is a result of their abilities and therefore alternate employment options. More capable employees generally have a greater number of more lucrative employment opportunities, thereby requiring larger salaries to retain them. Conversely, those with fewer employment options may value longer term employment for less salary. By having

options for a short and long-term contract, the firm can more easily identify those with better employment opportunities. Doing this allows them to contract those with fewer employment options and pay them less, thereby saving the firm money.

2. Scenario

Subjects in the experiment are initially one of one hundred employees at Firm A making an employment decision in uncertain conditions. In the scenario, Firm A is downsizing, with ten employees to be laid off in the first year. In subsequent years, further layoffs will occur; however, the exact number is uncertain at this stage.

For the controlled experiment, the only other option for employees is to work for Firm B, who has offered to employ all former employees of Firm A. Subjects have no preference for either firm and can make the transition to Firm B immediately or at any stage in the next five years. Once the transition to Firm B is made, they cannot return to Firm A. The subject's goal is to maximize their total income for the next five years.

C. INITIAL SALARY SURVEY

The initial survey instructions are included in Appendix A. In the scenario, Firm B presents a confidential salary offer to all Firm A employees. Subjects know that offers to other employees are evenly and randomly spread across an unknown range, and they do not know the value of other offers. Firm A asks employees to specify the minimum annual salary necessary to remain at Firm A. As Firm A will retain 90 of its 100 employees for the year, subjects are told that they will lay off those who submit the ten highest salary requests. Those laid off are immediately employed at Firm B and paid the amount offered by Firm B, with the remaining 90 employees remaining at Firm A for at least one more year.

The 90 employees to remain at Firm A will be paid the lowest salary requested by the ten laid off employees, or stated differently, the tenth highest salary request. Therefore, the salary paid to winners of the auction is always higher than the bid that they submitted. This is what characterizes the survey as a second price auction, with the subjects being the sellers of labor to Firm A, the single buyer.

Those employees who submitted the ten highest bids are not retained at Firm A. Instead, they shift employment to Firm B and are paid the amount of the initial salary offer for the next five years. In the experiment, the subject would be directed to information included in Appendix B, where they would be informed of their total five year income.

D. SECOND SALARY SURVEY

Subjects who win the first survey (i.e., among the 90 lowest bids) are directed to instructions for the second salary survey contained in Appendix C. They are told that they will be employed at Firm A for the next year and paid a salary equal to the tenth highest bid. Having previously been told that Firm A would lay off additional workers in subsequent years, the subject is now provided an estimation of the layoff percentage.

Subjects are then given information to assist them in calculating the expected value of their annual salary in the next five years. The information is presented in a table similar to Table 1. In this example, the subject was informed of a 30% layoff probability. The original Firm B offer was \$90,000. As they were among the winning bidders of the first salary survey, the subject would be paid \$142,466 in the first year (the bid of the tenth highest bidder of the first survey). While they are guaranteed to work for Firm A for at least one year, the table shows the other possible employment patterns in the five year period. Pattern 1 shows the income if subject is laid off at the end of the first year, and likewise, Pattern 2 shows the income if the subject is retained at Firm A for two years.

Table 1. Salary possibility example by employment pattern using a 30% layoff probability with “high” information

	<u>Pattern 1</u>	<u>Pattern 2</u>	<u>Pattern 3</u>	<u>Pattern 4</u>	<u>Pattern 5</u>
	Firm A for 1 Year	Firm A for 2 Years	Firm A for 3 Years	Firm A for 4 Years	Firm A for 5 Years
Probability of Pattern:	30%	21%	15%	10%	24%
<i>Year 1 Salary:</i>	\$142,466	\$142,466	\$142,466	\$142,466	\$142,466
<i>Year 2 Salary:</i>	\$90,000	\$142,466	\$142,466	\$142,466	\$142,466
<i>Year 3 Salary:</i>	\$90,000	\$90,000	\$142,466	\$142,466	\$142,466
<i>Year 4 Salary:</i>	\$90,000	\$90,000	\$90,000	\$142,466	\$142,466
<i>Year 5 Salary:</i>	\$90,000	\$90,000	\$90,000	\$90,000	\$142,466
<i>Total 5 Year Income:</i>	\$502,466	\$554,932	\$607,398	\$659,864	\$712,330
<i>Annual Average:</i>	\$100,493	\$110,986	\$121,480	\$131,973	\$142,466

Some subjects in the experiment are given more information than others. Specifically, those with a ‘high’ amount of information are presented a probability of each employment pattern occurring (shown as the first row in Table 1), whereas those with ‘low’ information are not. In the example, Pattern 1 shows that if a person was retained for one year at Firm A, they have a 30% chance of layoff for the second year (i.e., 70% chance of retention). Likewise, Pattern 2 shows that if they stayed with Firm A for two years (an event that has a 70% chance of occurring), with a 30% chance of layoff of those remaining, the probability of the employment pattern occurring is 21% (30% of 70% = 21%). The subjects given a ‘high’ level of information are provided instructions on how to calculate the “expected” annual salary over the five year period, and given the result of that calculation. The expected annual salary is a weighted average of the average annual salary presented in the bottom row of the table. Other subjects with a “low” amount of information are not provided this detail.

A second salary survey then takes place, where subjects bid for a five year employment contract. In the scenario, Firm A will give a five year employment guarantee to half of the retained employees. Firm A asks each of the 90 retained

employees to specify the annual salary they would need to remain with Firm A for the next five years. This survey determines which of the 45 employees are retained on a five year contract and their annual salary.

The second salary survey is much like the first salary survey in that the 45 employees who submit the lowest bid are given the employment guarantee. In the experiment, these subjects are directed to instructions at appendix D, which provides the value of the 45th highest salary request, or stated differently, the first losing bid. Winners of the contract are paid this sum annually for five years.

Those who submit bids above the 50th percentile are not necessarily stood down; instead, their continued employment at Firm A is based on the five probable employment patterns. Subjects are directed to instructions in Appendix E, where the experiment allocates an employment pattern based on the probabilities previously discussed. Subjects are then provided the five year total income from the sum of the annual salaries while working for either Firm A or B.

E. MOTIVATION

To ensure realism in bids, subjects in the experiment were paid an “experimental income.” The concept was that if real dollars were at stake for superior performance, subjects in the experiment would bid to maximize their experimental income, as would occur in reality if employees were bidding for their salary. As Norton (2006) states, “The promise of real money is a strong motivator in this experiment.”

Payment was based on the value of the subject’s total earnings over 18 rounds. Budgetary constraints and the number of experiment participants determined the exchange rate used. Subjects were paid \$1 for every \$450,000 earned in the experiment.

F. APPLICATION TO THE AUSTRALIAN ARMY

Design norms for economics experiments require a context free environment, so participants are motivated by the incentives built into the experiment rather than preconceived notions of how they should behave. Although the experiment focuses on

the employment decisions between two non-military firms, the decisions made in the experiment can be applied to employment decisions of a service person. The designers of the experiment, both employed by the U.S. Navy, clearly had a U.S. Military application in mind when creating the scenario. As a result, the experiment is extremely applicable to the employment decisions that U.S. Military personnel face today. While U.S. and Australian forces have many policy differences, the experiment also has a useful application for the Australian Army.

To draw an application to the Australian Army, one must first draw parallels to the two firms in the experiment. If the Army was to use the experiment, its role is represented by Firm A, while the experimental subjects (or Firm A employees) would be the soldiers. The salary bid made by experimental subjects would represent a soldier making a bid for either a pay rise or a retention bonus. Firm B would represent employers in civil industry making job offers to soldiers in an attempt to lure them from the service. Table 2 and Table 3 draw parallels between the experiment and the Australian Army for both the first and second salary survey.

Table 2. Experiment parallels to the Australian Army – first salary survey

Experiment	Apply to Australian Army
Firm A downsizing in the next five years, laying off 10% of workforce in the first year	The Australian Army is upsizing, but currently does not need to retain every soldier to do so. The Army needs to increase retention rates, but not make them 100%. For example, retention in a particular category may be 85% per year, but to meet future manning requirements, it may need to increase to 90%. The fact that it doesn't want to keep 100% makes this experimental condition appropriate.
Firm A will lay off additional employees in future years, but the exact number is uncertain (uncertainty is important to induce truthful bidding behavior)	The Army does not know the exact retention rate necessary in subsequent years, as it depends on discharges and resignations throughout the year, particularly from those who continued to serve without contractual obligations. The uncertainty in the experiment could also represent uncertainty about future bonus offers.
Firm B offers a salary but other employees don't know the value of the salary	The Firm B offer represents the service members civilian sector options, which likely vary across individuals. The Australian Army is small by U.S. Military standards. In selected specialist trades (for example dentists), it could be possible for all cohort members know one another. In small cohorts such as this, collusion could be a problem. However, in cases such as the AERRB where hundreds or people are eligible for a bonus, effective collusion is highly unlikely.
Firm A lays off the ten highest bidders	Current Australian Army policies would make it highly unlikely for losers of the auction to be laid off. However, it is highly likely that those not given a bonus would leave the service soon after. This is because if soldiers bid their true reservation value and it was sufficiently high to not receive a bonus, their civilian opportunities should be better. Any future service that the soldier provides would likely be short-term as they secure employment with a civilian firm.
Firm A retains 90 lowest bidders for the next year	In the example previously discussed where existing retention rates were 85%, the Army would then retain an additional 5% more than they would have otherwise. This has a secondary effect of reducing the workload of those who had previously been covering a vacancy and claim to have been "over worked and under paid." These people, with a lower workload, may be more willing to remain in the Army for longer, thereby improving retention in subsequent years.

Table 3. Experiment parallels to the Australian Army – second salary survey

Experiment	Apply to Australian Army
Firm A says they are going to lay off a certain percentage of workforce in future years	The Australian Army does not need to retain 100% of current serving soldiers, even with force expansion; however, the exact retention levels in subsequent years will change as a result of discharges and the number of people retained without bonus in the previous year. Therefore, the number of people who may be offered a bonus in subsequent years may differ. This can also reflect uncertainty about future bonus offers.
Firm A randomly selects those to be laid off.	This aspect of the experiment is difficult to apply to the Australian Army. The Army is unlikely to randomly select those it wants to retain, instead making posting and promotion possibilities better for those it wants to keep. These things have been demonstrated to effect a member's retention decision. It could be said, however, that the number of soldiers to be offered a bonus is unknown due to retention levels and budgetary constraints.
Firm A gives a five year employment guarantee to the half of the employees who are the lowest bidders for the five year contract	An employment guarantee is of no incentive to members of the Australian Army as they already have it – as long as they continue to provide effective service, they can continue to serve until retirement age (although they may not get the jobs and the promotion opportunities of the better performers). However, a guarantee that they will receive a bonus for five years would be attractive if there is uncertainty as to how many the Army needs to retain in future years and uncertainty in the budget for future retention bonuses.
Those who don't get the employment guarantee continue to work for at least one year, with a given probability of being laid off in any of the upcoming years	Those who didn't win the five year bonus guarantee could continue to serve on yearly contracts. The bonus availability would then depend on the budget and separation rates in that year (and the resulting retention rate required).

G. CONCLUSION

The experiment conducted at the Naval Postgraduate School in September 2007 is useful for the Australian Army to learn about the possible use of second price auctions to determine retention bonuses. While good parallels to the Australian Army can be drawn in the first salary survey, it is slightly more difficult to do so in the second salary survey. Regardless, as a learning platform, the experiment is useful and may provide a platform on which to base future experiments in the field.

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VI. EXPERIMENTAL RESULTS

A. INTRODUCTION

The previous chapter introduced the two-stage second price auction experiment conducted by Dr. William Gates and Dr. Peter Coughlan in 2007. The experiment had subjects initially bid for a one year salary at Firm A, with the firm laying off the 10 highest bidders out of a sample of 100. Those successful in the first salary survey were given the opportunity to bid for a five year contract at Firm A, offered to the 45 lowest bidders in the second salary survey. This chapter discusses the sample and the results of both the first and second salary survey.

B. SAMPLE

The experiment was conducted using 71 subjects from the U.S. Naval Postgraduate School and the U.S. Defense Language Institute. Each subject participated in 18 trials, thereby giving 1278 observations in the experiment sample. In the sample, the largest demographic group represented was a male enlisted person who had served less than five years in the military. Approximately 56% of the total sample had served less than five years. Females made up almost 13% of the sample, and while this may seem small, it approximates the proportion of women who currently serve in both the US and Australian forces. Figures 8–10 summarize the demographics of the experiment participants.

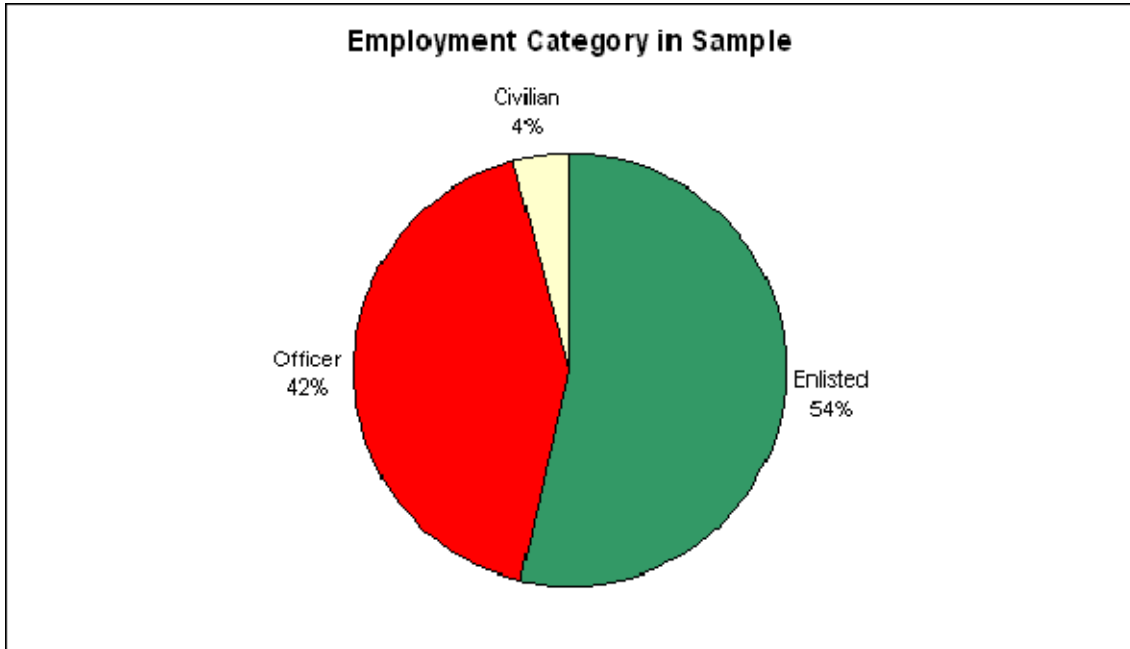


Figure 8. Employment category of experiment participants

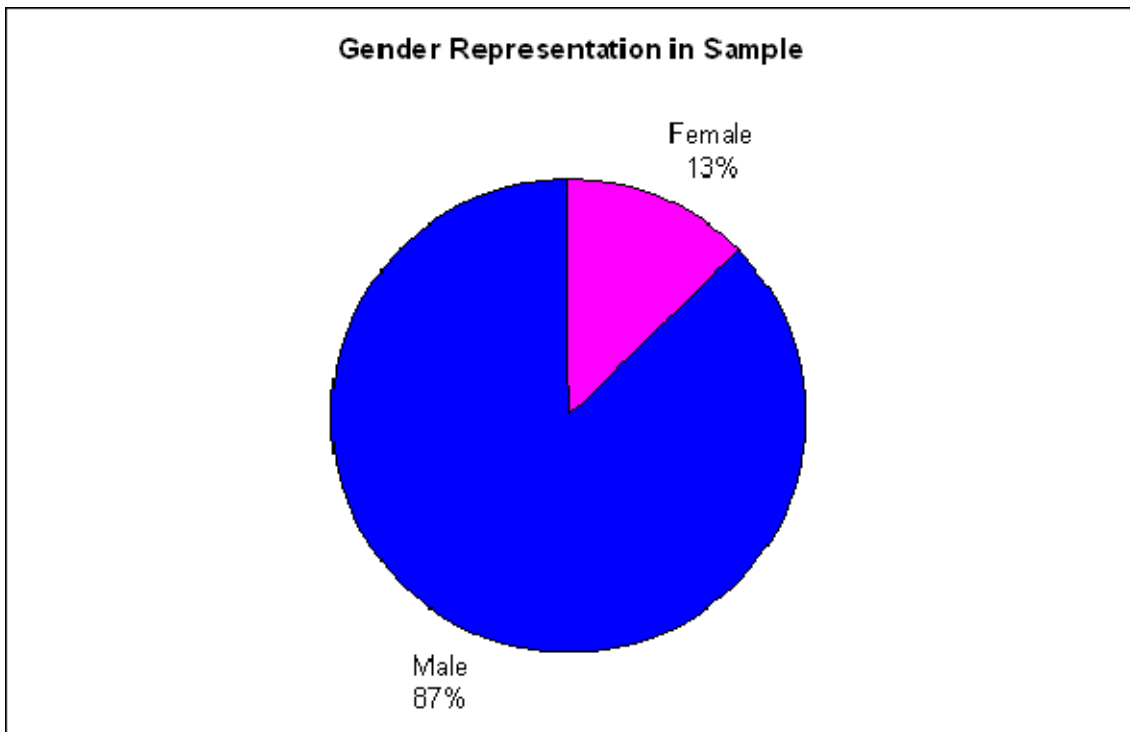


Figure 9. Gender representation of experiment participants

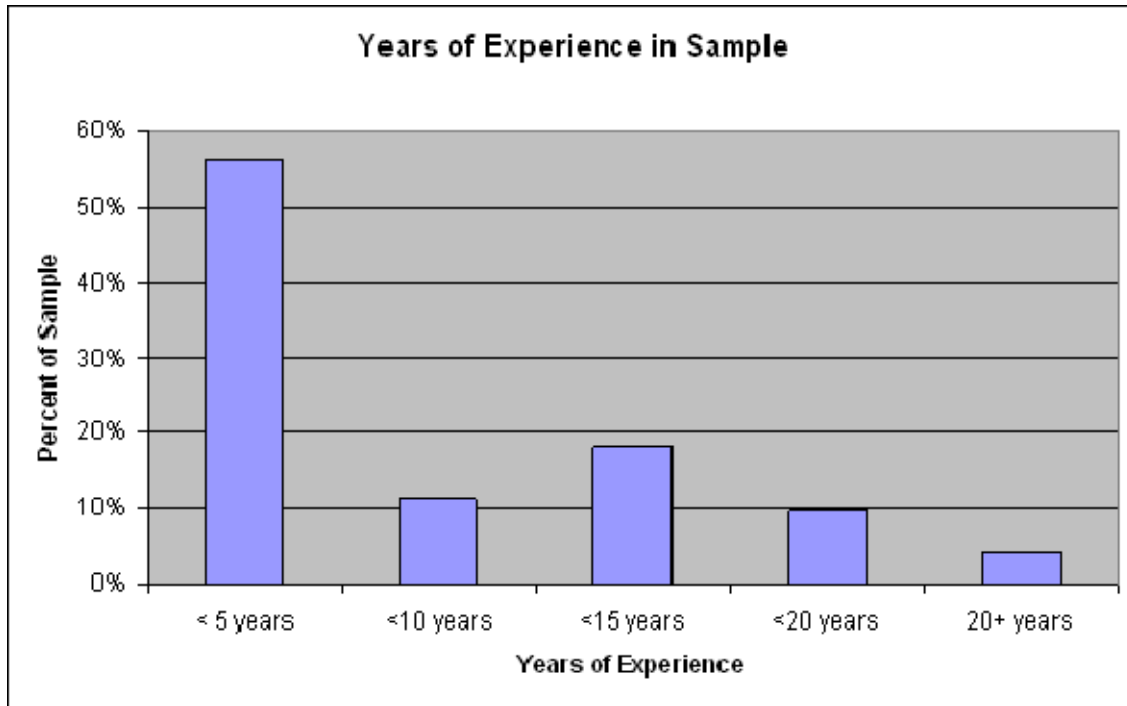


Figure 10. Years of experience of experiment participants

The sample was restricted to 70 subjects (1260 trials) as one subject was a clear outlier. This participant appeared to lose interest midway through the experiment, bidding either excessively high or low amounts, perhaps in an attempt to finish the experiment quickly. As the participant's bids were inconsistent with the rest of the sample, these observations were removed.

C. FIRST SALARY SURVEY

1. Descriptive Statistics

Firm B's salary offers were randomly generated and were different for each experiment trial. Consequently, an analysis of the bid to remain at Firm A itself carries little meaning, as the offer provided by Firm B is different in every trial. A more meaningful statistic to analyze is the individual's bid as a percentage of his/her opportunity cost, which can be easily compared across the sample. An individual's

opportunity cost is his/her next best alternative, which in this experiment is the salary offer presented by Firm B. The item of interest is therefore:

$$\text{Bid as a Percent of Opportunity Cost} = \frac{\text{Bid from Firm A employee}}{\text{Offer by Firm B}} \times 100$$

If a subject bids truthfully, as the literature suggests is optimal, this equation should equal 100%, indicating the subject bid exactly the offer provided by Firm B, or his/her opportunity cost.

The behavior of participants in the first salary survey varied. The histogram in Figure 11 shows the distribution of bids as a percent of opportunity cost. Of the 1,260 experimental trials, 141 participants bid the exact opportunity cost, with a further 99 cases where bids were within one dollar. These numbers indicated that 19% of the sample generally understood the auction’s optimum strategy. Interestingly, 47% of the sample made bids within 5% of the opportunity cost, indicating that just over half of the sample was represented in trials where the subject could not determine the optimal strategy or chose not to bid in accordance with it.

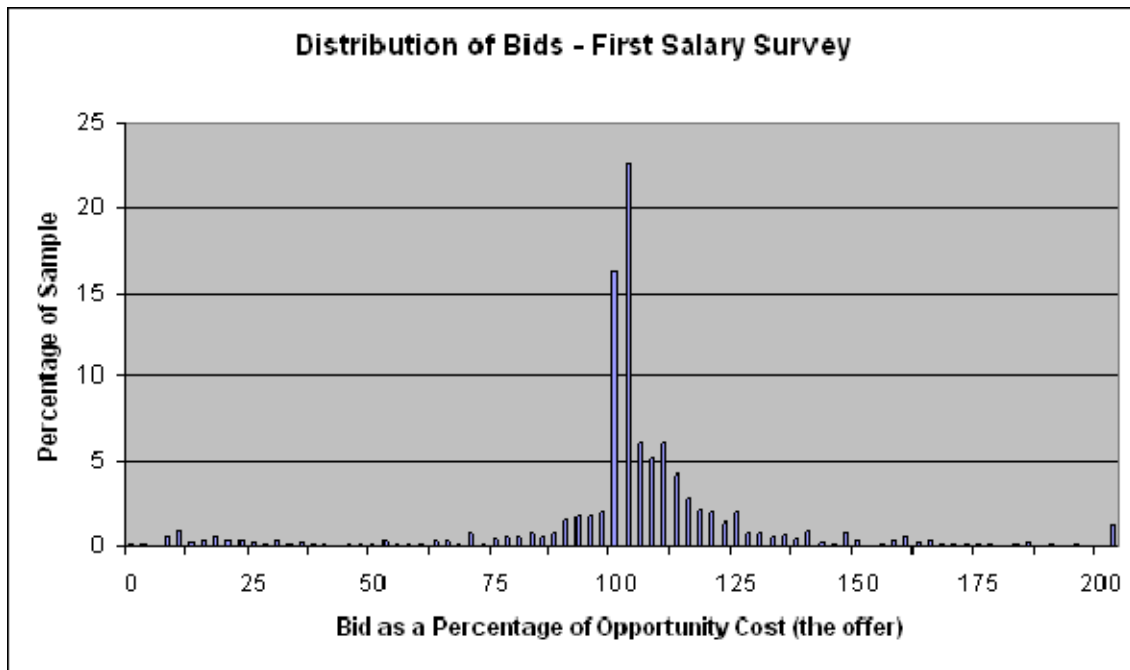


Figure 11. Distribution of bids as a percentage of the opportunity cost – first salary survey

A summary of the descriptive statistics of the first salary survey are provided in Table 4. The statistics demonstrate what appears to be over bidding, with 65% of the sample bidding above the opportunity cost.

Table 4. Descriptive statistics of the first salary survey – bid as a percent of the offer (opportunity cost)

Mean	104.5%
Median	100.9%
Mode	100.0%
Standard Deviation	49.1%
Minimum	0.0%
Maximum	1,266.9%
95 % Confidence Interval around the mean	101.8 - 107.1%
Bid within 5% of Opportunity Cost	47.1%
Bid at Opportunity Cost	11%
Bid above Opportunity Cost	65%
Bid below Opportunity Cost	24%

A t-test of the mean confirms the over bidding to be more than just statistical error. There is overwhelming evidence to suggest subjects bid above their opportunity costs.

2. Regression Analysis

A regression analysis was conducted to isolate the elements that affect bidding behavior in the first survey. The results of this regression are contained in Table 5.

Table 5. First salary survey regression results

	Regression 1	Regression 2
	Bid as a % of Opp Cost	Bid as a % of Opp Cost
Round Number	-1.455	-1.455
	(0.264)***	(0.262)***
Subject Pool (NPS=1)	-0.625	-3.376
	(2.741)	(4.540)
Years of Service		0.236
		(0.337)
Female		-14.378
		(4.168)***
Constant	118.580	120.159
	(3.133)***	(3.231)***
Observations	1260	1260
R-squared	0.02	0.03
Standard errors in parentheses		
* significant at 10%; ** significant at 5%; *** significant at 1%		

The number of years a person had served in the military is essentially a proxy for age. Surprisingly, both this and the subject pool (whether a subject was currently at the Naval Postgraduate School or the Defense Language Institute) were found to have no effect on bidding behavior.

Gender is a highly significant element in the first salary survey. The regression demonstrates that holding all else constant, females bid 14 percentage points lower than their male peers. Given that the sample mean indicated overbidding of approximately 4%, this result indicates that the women in the sample tended to underbid in the first salary survey.

Finally, the regression analysis reveals that the round number is highly significant and negative. Holding all else constant, the results indicate that an individual would bid approximately 1.5 percentage points lower in each round of the experiment. In layman's terms, this shows that even though subjects bid on average above the opportunity cost, the over bidding decreases in each round. Remembering that each subject participated in 18 separate rounds of the experiment, this result demonstrates a powerful learning effect.

3. Learning Effect

Subjects in the experiment were not presented information about the nature of a second price auction or its dominant strategy. Despite the absence of formal instruction, subjects received feedback through the salary they achieved at the end of each round, highlighting to them the success (or otherwise) of their bidding strategy. With this feedback, one would expect subjects to improve with experience, a hypotheses supported by the regression results. However, the result from the regression of a 1.5% bid reduction for each round would imply underbidding in the latter rounds. This was not the case.

To understand the rate at which the learning occurs, the bid behavior was compiled for each experimental round. Figure 12 shows the mean and standard deviation of the bid across the 18 experimental rounds.

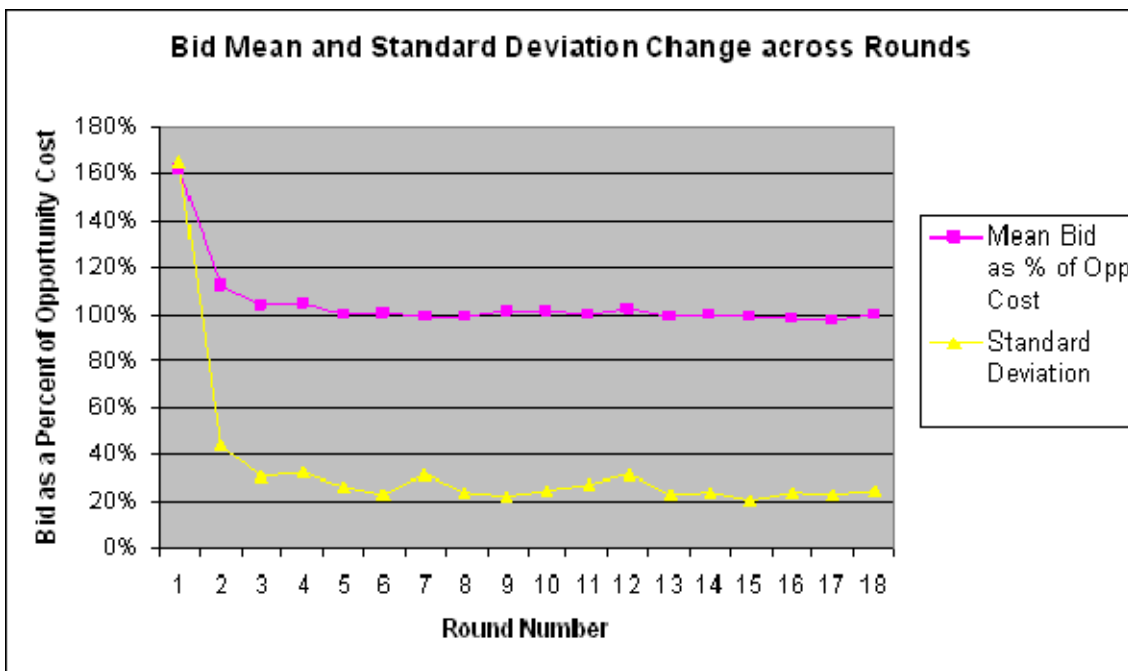


Figure 12. Bidding behavior across experimental rounds – first salary survey

The graph shows that the majority of the learning occurs in the first four rounds; beyond that there is very little variation in the mean and standard deviation. Underbidding in the latter rounds was not present, and the graph demonstrates the mean settling at approximately 100%.

4. Revision of Sample Mean

Omitting rounds from the data where learning is occurring has a dramatic effect on the experimental results. Assuming the learning is complete by the end of the 4th round, an analysis was conducted on rounds 5 through 18. Table 6 demonstrates that in the latter half of the experiment, subjects bid as the theory suggests. This result demonstrates that after initial learning has occurred in the first four rounds, it is difficult to prove that participants bid differently from the dominant strategy.

Table 6. Descriptive statistic comparison of total sample to experimental rounds 5-18 of the first salary survey

	Total Sample	Rounds 5-18
Mean	104.5	99.8
Standard Deviation	49.1	25.0
Minimum	0.0	0.0
Maximum	1266.9	233.4
95 % Confidence Interval around the mean	101.8 – 107.1	98.2 – 101.3
t test: Mean = 1	P value = 0.000	P value = 0.772

D. SECOND SALARY SURVEY

In the experiment scenario, Firm A intended to retain 90 out of 100 employees, laying off the employees with the 10 highest bids. Therefore, depending on the size of the bid in the first salary survey, an individual may or may not have an opportunity to bid for a five year contract in the second salary survey.

1. Sample

Out of the first salary survey of 1260 participants, 1047 were successfully retained at Firm A for an additional year, meaning they had an opportunity to bid for a

five year contract in the second salary survey. Remarkably, there were no major differences to the sample representation from the first survey in terms of gender, employment category or years of experience.

The survey did however have a small number of outlying bids that significantly affected the mean and standard deviation of the sample. In particular, a few outlier bids were so unreasonable that they seemed to indicate behavior in which the subjects in question were not attempting to make the best choice but were simply “testing” or “playing” with the experiment software for a trial or two to see what would happen. As a consequence, bids in the upper and lower 0.5% were removed from the sample. This restricted the observations analyzed in the second salary survey to 1037.

The previous chapter highlighted that subjects were presented differing levels of information. The availability of employment pattern probabilities, as well as the means of deducing the “expected salary” were the key differences between those presented high or low levels of information. There were an approximately equal number of subjects presented low and high levels of information, with 47.3% of the sample presented the high information level.

The previous chapter also indicated that subjects received varying layoff probabilities in the second salary survey. There were three yearly layoff probabilities employed in the experiment: 10, 20 and 30%. Layoff probabilities were equally allocated throughout the sample, with approximately one third of the sample allocated to each group.

2. Descriptive Statistics

Like the first salary survey, analyzing the value of individual bids is of little value since salary offers by Firm B (on which participants base their bids) are randomly assigned to each experimental trial. If subjects are risk neutral and bid rationally in accordance with the dominant strategy, then their optimal strategy is to bid the “expected” value of the annual salary over five years. Therefore, the most meaningful statistic to analyze is an individual’s bid as a percent of expected annual salary, which shows the percentage a person overbid or underbid. The item of interest is therefore:

$$\text{Bid as a Percent of Expected Annual Salary} = \frac{\text{Bid for 5 year salary}}{\text{Expected Annual Salary}} \times 100$$

In the above equation, if a risk neutral subject rationally bids the expected annual salary, then this equation would equal 100%.

The behavior of participants in the second salary survey varied more than that of the first. This was expected, as the second salary survey introduced factors such as varying layoff probability and varying levels of information about the value of the expected future income. This made the second salary survey more complex than the first, which consequently widened the bidding distribution. The histogram at Figure 13 shows the distribution of bids as a percent of their expected annual salary.

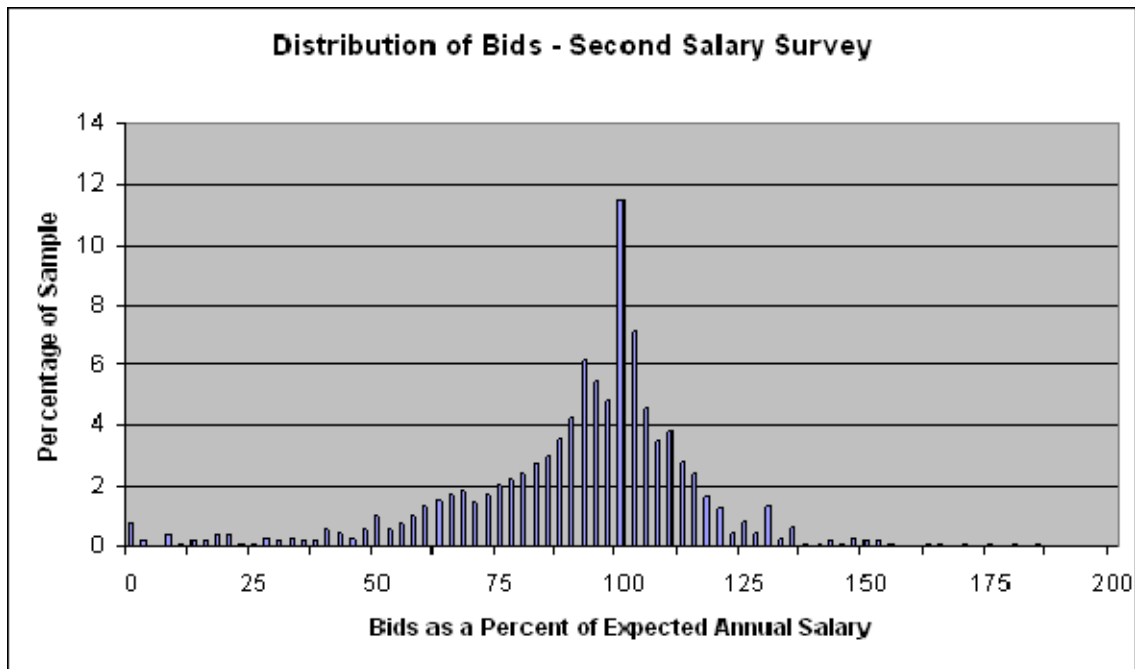


Figure 13. Distribution of bids as a percent of the expected annual salary

The distribution of bids is skewed to the left, resulting in a mean of 90.1% of the expected annual salary over five years. A much smaller number of participants in the second survey bid as the literature suggests, where in just 39 of the 1037 trials,

participants bid the expected annual salary. A further three subjects made bids within one dollar of the expected value, giving approximately 4% of the sample bidding rationally.

A summary of the descriptive statistics of the second salary survey are provided in Table 7. The statistics demonstrate what appears to be a preference of underbidding, where 63% of the bids were below the expected annual salary.

Table 7. Descriptive statistics in the second salary survey

Mean	90.1%
Median	94.7%
Standard Deviation	25.1%
Minimum	0.0%
Maximum	182.7%
95 % Confidence Interval around the mean	88.5% - 91.6%
Bid within 1% of Expected Annual Salary	12%
Bid at Expected Annual Salary	4%
Bid above Expected Annual Salary	33%
Bid below Expected Annual Salary	63%

A t-test of the mean confirms the under bidding to be more than just statistical error. The test reveals overwhelming evidence to suggest subjects bid below the expected value of their annual salary over five years. This result may indicate risk aversion, which will be discussed later in the chapter.

3. Low vs. High Information Comparison

As explained earlier, approximately half of the sample was given information about the expected annual salary whereas the other half was not. If subjects used the information correctly, one would expect those with more information to bid closer to the expected annual salary. Table 8 presents descriptive statistics of both Low and High information samples.

Table 8. Descriptive statistics of bids for the different information levels

	Low Information	High Information	Entire Sample
Mean	89.4%	90.8%	90.1%
Median	93.0%	96.9%	94.7%
Standard Deviation	26.3%	23.8%	25.1%
Minimum	0.0%	0.0%	0.0%
Maximum	182.7%	154.9%	182.7%
95 % Confidence Interval around the mean	87.2 - 91.7%	88.7 - 92.9%	88.5 - 91.6%

The main difference in the low and high information groups appears to be the variation of bids within the groups. An f-test was conducted on the two sample variances to establish whether they could be considered statistically equivalent, with the null hypothesis of the test that they were. With a p-value of 0.025, there was strong evidence to suggest that the information given to subjects affects the variance of the bids.

The sample mean of the two groups is, however, very similar. A two sample t-test (assuming unequal variances) was conducted to establish whether the means of the two groups are statistically equivalent, with the null hypothesis that they are equal. With a p-value of 0.40, there was insufficient evidence to reject the null hypothesis. Therefore, the hypothesis that the average bid of those presented with high information differed from those with low information is not supported.

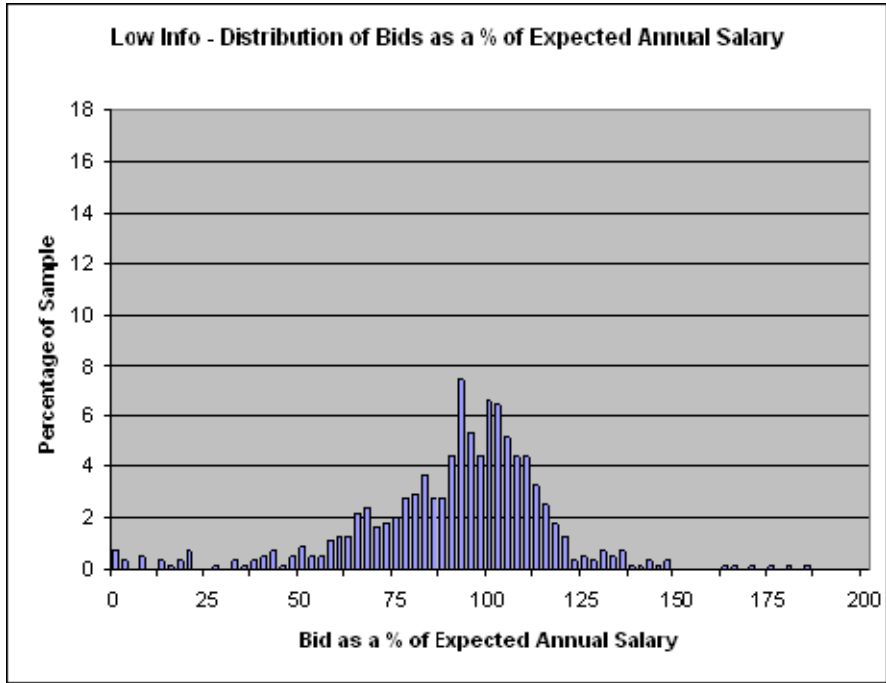


Figure 14. Distribution of bids as a percent of expected annual salary – low information sample

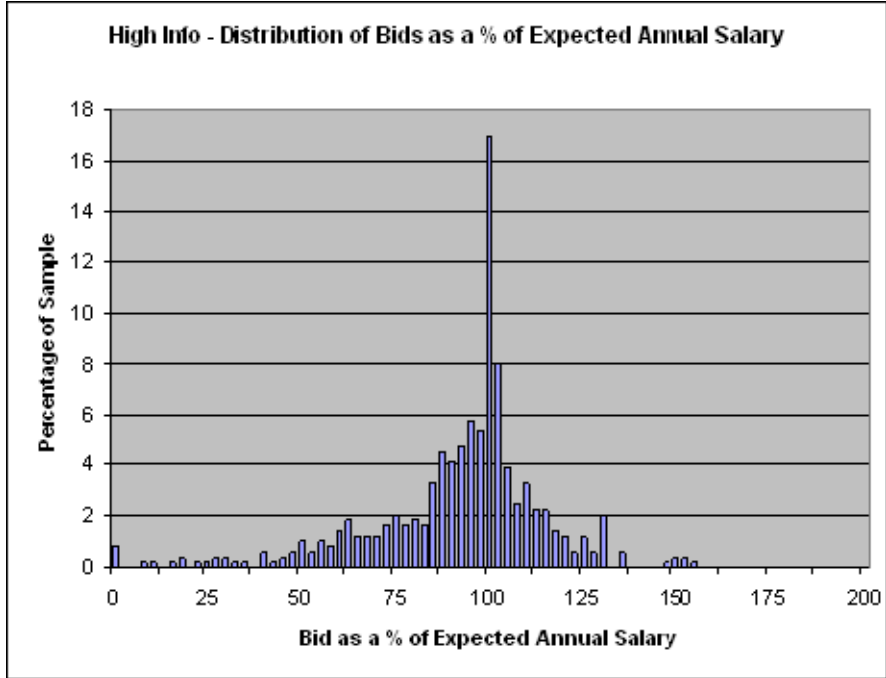


Figure 15. Distribution of bids as a percent of expected annual salary – high information sample

The graphic illustration in Figures 14 and 15 supports the test results. While more information concentrates the sample around the mean, it does not appear to change the mean. Whether presented more or less information, the subjects in the experiment on average still bid below the expected annual salary by approximately the same amount. One explanation is that the risk-averse nature of the subjects dictated that subjects in both samples generally wanted to bid at a certain amount below the expected value, and high levels of information simply assisted them to more accurately achieve this target.

4. Learning Effect

A powerful learning effect was observed in the first salary survey but was not observed in the second. Figure 16 shows the bid mean and standard deviation by round. While both mean and standard deviation are relatively consistent over the rounds, there appears to be no obvious trend. This may have been because the additional complicating factors introduced in the second salary survey made it more difficult to learn. Overall, subjects do not appear to change their bids with experience in the second salary survey.

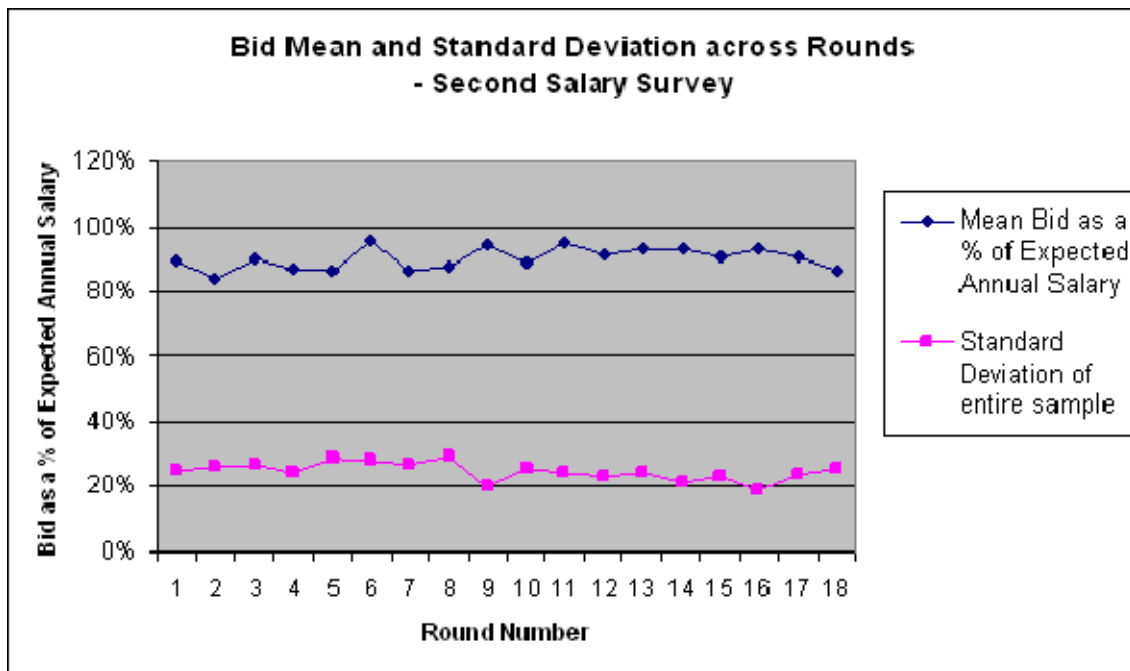


Figure 16. Bidding behavior across rounds in the second salary survey

5. Regression Analysis

A regression analysis was conducted on the second salary survey data to isolate elements that affect bidding behavior in the second survey. Regression results are contained in Table 9.

Table 9. Second salary survey regression

	Regression 1	Regression 2
	Bid as a % of Expected Annual Salary	Bid as a % of Expected Annual Salary
Round Number	0.16940 (0.16164)	0.17989 (0.16149)
Subject Pool (NPS=1)	-3.48726 (2.69832)	
Info Code (High=1)	0.74306 (1.69110)	0.29963 (1.65647)
Layoff Prob 20%	4.32428 (1.94990)**	3.97938 (1.93218)**
Layoff Prob 30%	5.88258 (1.89592)***	5.81408 (1.89580)***
Years of Service	0.02458 (0.20119)	-0.18704 (0.11694)
Female	-4.48418 (2.37159)*	-5.07748 (2.32749)**
Constant	86.71907 (2.16613)***	86.80143 (2.16590)***
Observations	1037	1037
R-squared	0.02	0.02
Standard errors in parentheses		
* significant at 10%; ** significant at 5%; *** significant at 1%		

The regression shows that the round number and the information level did not have a significant effect on bidding behavior, a result not surprising given the previous discussion. Being female was significant at the 5% level, meaning that holding all else constant, we can be 95% certain that females bid lower in the second salary survey than their male peers. In the experiments, on average the females bid 5.08 percentage points below the males, indicating they were more risk averse. This result is consistent with the findings of the first salary survey.

Like the first salary survey, the subject pool effect was insignificant. NPS and DLI have people with different levels of experience, education, and age. While it was thought that the subject pool variable could have been correlated with the years of service, omitting the subject pool in regression 2 of Table 9 failed to make the years of service variable significant.

Interestingly, the number of years of service was not significant at the 10% level (although its p-value was 0.11). In the experiment, years of service served as a proxy for age, and a person's age is often a reflection of their stage of life and attitude towards risk. It was therefore expected that those with more years of service would bid lower. This effect was not observed in the data.

Bids with higher layoff probabilities resulted in higher bids, although they were still below the expected annual salary for the entire sample. Subjects given 20% and 30% layoff probability bid 4.0 and 5.8 percentage points higher respectively (and closer to the expected annual salary) than a subject with a 10% layoff probability. The reason for this may be that those presented with greater levels of risk respond by bidding somewhere between their best case scenario (staying with Firm A for five years) and worst case scenario (being laid off from Firm A after one year). This result indicates that subjects may insufficiently change the weighting of their best and worst case scenarios as the layoff probabilities change, choosing a "middle of the road" value under all layoff probabilities.

6. Cost Savings Achieved with the Second Stage Auction

Excluding the first four rounds where subjects were learning, there were 287 trials where subjects successfully bid and won the long-term contract. To retain this small group seeking the long-term contract, Firm A saved 46.7% in salary that they would have otherwise paid. In reality, however, Firm A would be interested in the savings in the total salary bill, not just those who selected the long-term contract. Table 10 presents these savings by year. The table shows that greater savings are made in latter years, as more of

the short-term contracted are laid off while the number of lesser paid long-term contract employees remains constant. Across the five years, Firm A would have made salary savings of 6.49% by adopting this strategy.

Table 10. Total salary savings by incorporating the second stage auction

	Savings (%)
Year 1	5.56
Year 2	5.82
Year 3	6.36
Year 4	7.20
Year 5	8.17

E. DISCUSSION

In general, the bids in second salary survey are lower than in the first salary survey – both overall and relative to the optimal risk-neutral bid in each survey. Preconceived ideas that a person should be paid less for a long-term contract, as well as confusion with the additional complexities of the second salary survey may go part way to explaining lower bidding. However risk aversion is likely be the major factor causing lower bidding in the second salary survey.

Low bids in a second price auction often signal risk aversion. In the previous chapter, it was highlighted that attitude towards risk should not change the fact that it is optimal to bid one’s true reservation value in a second price auction. This does not mean that those bidding low in the second salary survey have bid irrationally; instead they may have rationally determined a reservation value less than the expected annual salary, and therefore bid that amount. A person choosing a lower reservation value might do so for non-economic reasons, perhaps valuing long-term job security more important than income. For example, a person may aim to win a long-term employment contract for income consistency to pay their mortgage. The amount an employee bids below the expected annual salary reflects his/her level of risk aversion.

Despite the reasons for bidding lower for a long-term contract, one thing is clear: the presence of risk aversion benefits the service as much as the individual. This is

because the service could pay less to retain those on long-term contracts. The experimental data suggests that by offering a five year contract to half of its retained employees, Firm A could make 6.49% saving in total salary over five years.

F. CONCLUSION

In what was one of the first known experiments using a second price auction in the labor market, the experiment revealed some interesting results. The results show that it may require some learning or experience with the second-price auction to achieve accurate revelation of an individual's reservation value. Training before a real scenario therefore may be vital to the success of the auction. Finally, the results indicate that people do not always bid with their heads but with their hearts; that is, despite the fact an individual could maximize their income by bidding differently, some value long-term employment or a stable stream of income more highly, and these risk averse participants can benefit both themselves and the service. The next chapter discusses the effectiveness of the salary auction method applied to the Australian Army.

VII. ANALYSIS

A. INTRODUCTION

This chapter provides a more in-depth discussion into some of the issues that face the Australian Army, should they adopt a retention bonus auction such as that discussed in the previous chapter.

B. QUALITY OF SOLDIERS RETAINED

Military retention bonuses, whether set by auction or prediction techniques, typically attract those with fewer civilian alternatives. Those with higher opportunity costs are more likely to leave the service sooner, preferring to avoid the obligation of a long-term contract. Unfortunately for the service, those with greater civilian opportunities are often the more capable soldiers. Without controls, any retention bonus system could arguably reduce the quality of the force.

An important factor in retaining high quality soldiers is preventing poor performing or unqualified soldiers from being eligible to receive a retention bonus. Such a policy should exist no matter how the bonus level is determined.

A two stage auction where soldiers get an opportunity to bid for a short- and long-term contract may also assist in keeping force standard high. While better performing soldiers may not want a long-term contract, their high bid for a short-term contract may be accepted. The service would prefer to contract high performers for longer, but they would accept that some additional service is better than nothing.

C. IMPORTANCE OF A LONG-TERM CONTRACT OPTION

The results of the experiment show that a two stage auction offering a longer term contract in the second stage has cost advantages over a single stage second-price auction. Bock (2007) outlines that cost savings are maximized when there is uncertainty about opportunities with the short-term contract. Such uncertainty could be budgetary, in that

constraints could either reduce or eliminate future short-term bonuses. Differing retention requirements in future years could add further uncertainty. As Bock points out, “the element of uncertainty induces more individuals to accept the long-term contract,” thereby returning savings to the service. This was certainly the case in the experiment, where risk averse bidding for a five year employment contract would have returned average savings on the order of an additional 6.5% per year to Firm A over five years.

D. LEARNING AND TRAINING

The powerful learning effect of the first (and most simplistic) salary survey was discussed in the previous chapter. When additional complexities were introduced in the second salary survey, a learning effect was not observed. Subjects having to learn and understand the experimental scenario to bid rationally contributed to the complexity of the second salary survey. If such salary surveys were conducted in reality, auction participants would most probably understand the situation that they were in, meaning there would be one less thing to learn. Instructions could therefore be reduced, using them solely to explain the auction itself.

To further simplify the auction mechanism, it would be important to deliver a training package before the auction. Training could explain a second-price auction with simple examples. Importantly, training could focus on the dominant strategy of a second-price auction, explaining that, on average, a person could not make themselves better off with any strategy other than bidding their true perceived value. Examples demonstrating the effect of both a high and a low bid would help convince soldiers of the best way to maximize their income. Additionally, an example of a collusion attempt failing would help prevent soldiers from “bidding-up” a bonus.

With auction training, the bidding behavior of the second salary survey is likely to be more consistent. This would lead to a more condensed distribution of bids, although “under-bidding” relative to the expected value is likely because most individuals are risk averse and prefer long-term job security over maximizing expected income.

E. IS THE NUMBER WHO WILL RECEIVE THE BONUS IMPORTANT?

In the experiments, subjects were told how many of their fellow employees would be retained from the survey. There were two main reasons for revealing this information: first, it simplified the experiment, and second, it increased transparency, thereby fostering trust in the system. There are, however, disadvantages to revealing retention goals, including making collusion easier and reducing flexibility to the service (Dr. P. Coughlan, personal communication, 17 Mar 2008). An auction that does not disclose retention targets allows the Army to choose the cutoff bid (and therefore the number to be paid a bonus) after the auction, depending on the allocated budget. This permits the service to offer a bonus to all eligible soldiers in times where manning is critical and the highest bid is within budgetary constraints. On the other hand, when the budget is tight and the marginal benefit of additional soldiers is less than the marginal cost of retaining them, the Army could reduce the number of soldiers offered the bonus.

F. BUDGET

It would be naïve to think that budgets for retention bonuses are unlimited. A restricted budget for retention incentives is one of the contributing factors to the manning shortfall in the Australian Army today. While forecasts may predict a necessary bonus larger than the service can afford to pay, the restricted budget is (and must be) applied, as some improvement in retention is better than none at all. Applying this logic to the retention bonus auction, the budget constraint must be considered when setting the auction cut-off bid.

Assuming that retention goals within a particular employment category are not disclosed, the Army could receive bids from all employment categories before deciding how many from each to offer a retention bonus. With this information, the Army can project costs to meet its retention priorities. With budgetary constraints, the Army could allocate its funds to receive the “biggest bang for its buck,” taking into account the marginal benefit and cost of additional soldiers previously discussed.

Without an unlimited budget, it is impossible to guarantee all retention priorities will be met; however, the use of an auction will ensure the Army meets more of its targets than they would otherwise.

G. TRUST

The success of a second-price auction to set a retention bonus could not be achieved without trust from both parties. On one side, the service will expect winning bidders to sign an employment contract based on their bid, as is customary in any auction-based transaction. On the other side, soldiers must trust that the Army will honor their bids in a true second-price auction, equally paying all eligible winners. Trust would be compromised if the Army chose to pay smaller amounts to low bidders and larger amounts to higher bidders. In short, once bids were received, the Army could not change the auction format.

H. BIDDING IN SMALL COHORTS - COLLUSION

The question of whether retention bonuses set with an auction are equally effective in small cohorts is of great interest to the Australian Army. Being a comparatively small force, the Australian Army has many cohorts of soldiers and officers where numbers are sufficiently small that all members know one another. Collusion among a small group to “bid up” the bonus is possible.

For example, take a scenario where the Army wants to retain nine soldiers out of a small employment group of ten. Suppose that the ten soldiers are all friends, who work and play together. If the Army requested bids for a bonus, offering to pay the nine soldiers with the lowest bids a bonus equal to the one excluded bid (that of the tenth soldier), then one of the friends would not receive the bonus. While collusion may increase the price of the auction, the fact remains that one soldier (the highest bidder) does not receive the bonus, becoming the sacrificial lamb for his friends. Had he acted counter to the collusive agreement by bidding more conservatively, he may have received the bonus at the expense of one of his peers. An individual soldier, therefore, has no incentive to bid an amount higher than what he would need to remain in the service. At

the same time, he has no incentive to bid lower than his reservation value because he may end up being retained under contract for a bonus less than he could receive as a civilian. Therefore, even when the retention goal is revealed in this small group, individual soldiers can do no better than to bid their reservation value.

The Army could discourage inflated bids resulting from collusion by not disclosing retention targets. In the unlikely scenario that an individual wants to leave the service for non-financial reasons and chooses to be the sacrificial lamb for his friends, the Army could easily lower the cutoff bid. This would only result in one less soldier contracted and avoid excessive resource wastage as a result of one conspiratorial bid.

In summary, the effect of collusion should be of little concern to the Army. There are steps the Army can (and should) take to minimize collusion; however, even without it, the average individual has little to gain by collusion.

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VIII. CONCLUSION AND RECOMMENDATIONS

A. CONCLUSION

The practice of setting retention bonus levels based on historical data has served the U.S. Military well. Retention bonuses calculated as such have been far more effective than other retention incentives, although all U.S. services are concerned about the cost of their bonus program. Despite their relative effectiveness compared to other retention programs, predicting bonuses using historical data is not always precise; the services can either face excessive expenditures with too much retention, or fail to meet their retention goals. The Australian Army will undoubtedly be less precise, without the benefit of 40 years of historical data.

1. Primary Research Question Answered

The literature shows that a second-price auction is truth revealing, in that the dominant strategy is to bid one's reservation value. A labor market experiment using a second-price auction to determine employee salaries supports the literature. The experimental results suggest that a second-price auction has potential to determine retention bonus levels. Specifically, a second price auction will allow the Army to retain the exact number of soldiers required at the lowest cost possible or, alternatively, retain the maximum number of soldiers within a given budget constraint.

2. Secondary Research Questions Answered

When a second auction is conducted allowing winners of the first auction to submit another bid for a long-term contract, the auction becomes even more cost effective. Cost savings occur as a result of preferences for long-term security over income maximization. While the experiments reveal an average cost saving of 6.49% per year over five years, the savings of the second stage depend heavily on the auction scenario, the number of long-term contracts available, and the resignation rate of those at the end of their short-term contracts.

For the Australian Army, the uncertainty as to whether a bonus will be available in future years (and the amount of any such bonus) should motivate some individuals to accept a longer term contract (and therefore lower bonus per annum). This uncertainty returns cost savings to the service, as well as a long-term commitment from a body of soldiers that otherwise would not be under contract.

If the Army is prepared to forgo the cost saving of a second salary survey, instead accepting the cost that would otherwise result from a single stage auction, it is possible to retain more capable soldiers with attractive civilian employment opportunities. This could be achieved by raising the cutoff bid in the first salary survey (thereby enticing more “high quality” soldiers) because of the anticipated savings of the second salary survey.

The Army can reduce bid inflation resulting from collusion by not disclosing retention goals. By also making it clear that the number of soldiers offered a bonus will depend on budgetary constraints and the value of bids, colluded bid inflation becomes less attractive, particularly in small cohorts of soldiers. However, even if the Army chose not to address the issue of collusion and to disclose retention targets, the outcome of the auction is unlikely to be effected when income maximization is the primary motivator. Bid inflation only increases the chance that an individual misses out on a bonus altogether when they otherwise would have accepted a lower bonus.

A training package is almost certain to help induce truthful bidding behavior. A second-price auction is not a familiar process to the average person, and without explaining it, soldiers may end up guessing how to maximize their bonus. A soldier missing out on a bonus, when he understood his worth in civilian industry but not the auction mechanics, is likely to create unnecessary administrative and legal issues. To avoid these un-pleasantries, it is important to ensure all participants understand the process through good training and by keeping the auction as simple as possible.

When setting retention goals for a bonus auction in the Australian Army, it is important to remember that additional people may be retained without a retention bonus due to the open-ended engagement policy. This means that those ineligible for the

auction and those who bid too high could conceivably continue to serve without a bonus, although any service provided is likely to be short-term. Those who bid too high have effectively told the Army that their employment options are better in civilian industry, meaning they are likely to look for alternate employment in the near future.

3. Other Research Findings

The intention to make retention bonuses in the Australian Army short-term measures, before other sustainable conditions are in place, may not be as effective as it sounds. Research on U.S. Military retention incentives shows that dollar for dollar, bonuses are the most effective retention tool employed. While the effect could be different in the Australian Army, it may be too soon to flag retention bonuses as merely short-term measures; further Australian research in the area may be warranted.

Other research in the U.S. reveals that paying retention bonuses “up front” has a greater impact than paying throughout the contract, or worse still, at the end of the contract. In particular, U.S. service members have demonstrated a preference for up-front bonuses even when the bonus amount is lower than the present (or discounted) value of an alternative set of future payments. Thus, up-front bonuses are not only more effective but also more affordable for the military. This means that an AERRB retention bonus that pays \$10,000 up front for a one year commitment is significantly more effective than a completion bonus that pays \$30,000 at the end of a further three year commitment. For a better bang for buck, the Australian Army should make future retention bonuses up front payments, whether set by auction or otherwise, trusting the contractual obligations to ensure soldiers fulfill their commitment.

B. RECOMMENDATIONS FOR FUTURE STUDY AND DEVELOPMENT

Further experiments are necessary before introducing a second-price retention bonus auction into the service. The Australian Army should look to conduct such experiments using a larger and representative sample of its own personnel. Building upon the successful experiments conducted by Gates and Coughlan in 2007, the next phase of experiments should also be non-military and generic in nature. This will allow

valuable data to be gathered without confounds such as individuals having differing civilian options, which makes it difficult to know if subjects are bidding truthfully. Experiments should focus on the issues listed below:

- The improvement in bidding behavior as a result of training. Training should be conducted prior to the experiment so that subjects understand the concept of a second-price auction, what it is trying to achieve, and the dominant strategy. The training package effectiveness should be assessed by the distribution of bids and the number of rounds before subjects begin truthfully revealing their reservation value.
- Subjects should bid against each other (instead of competing bids being generated by a computer simulation). This will allow the effects of collusion to be analyzed in greater detail to establish if behavior matches theoretical expectations. A control group should be established (where no collusion is permitted) so that bidding behavior can be compared to a group where subjects can collude with fellow subjects.
- The effect of revealing the retention goal should also be analyzed. Bidding behavior in auctions where the firm reveals retention goals should be compared to auctions where targets are not revealed. These tests should be conducted with and without collusion.

Focus groups should also be conducted to gain an understanding of the concerns regarding a retention bonus auction. Ideally, subjects from the experiment would also be involved with the focus groups. The focus groups will allow the concerns of the soldiers to be addressed by improving the process, instructions and training package.

The ultimate mid-term goal would be to put the concept to the test on a small cohort of soldiers bidding for a real retention bonus. It will only be through this final step that the concept can be refined before introducing the concept service wide.

APPENDIX A. SECOND-PRICE SEALED BID AUCTION INDIVIDUAL CHOICE EXPERIMENT INITIAL SALARY SURVEY

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:

\$90,000

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 and will work for Firm B for the next 5 years at the salary offer above.

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: \$145,000

PROCEED

APPENDIX B. SECOND-PRICE SEALED BID AUCTION INDIVIDUAL CHOICE EXPERIMENT - ABOVE 90TH PERCENTILE

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: **\$40,000**

The *highest* annual salary request submitted to Firm A by one of its other current employees was: **\$100,000**

The *10th highest* annual salary request submitted to Firm A by one of its current employees was: **\$142,466**

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:

<i>Year 1:</i>	\$90,000
<i>Year 2:</i>	\$90,000
<i>Year 3:</i>	\$90,000
<i>Year 4:</i>	\$90,000
<i>Year 5:</i>	\$90,000
Total:	\$450,000

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 \$450,000 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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APPENDIX C. SECOND-PRICE SEALED BID AUCTION INDIVIDUAL CHOICE EXPERIMENT - BELOW 90TH PERCENTILE

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: **\$40,000**
 The *highest* annual salary request submitted to Firm A by one of its other current employees was: **\$100,000**
 The *10th highest* annual salary request submitted to Firm A by one of its current employees was: **\$142,466**
 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 10 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 10th 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: **30%**

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: **70%**

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:

	<u>Pattern 1</u>	<u>Pattern 2</u>	<u>Pattern 3</u>	<u>Pattern 4</u>	<u>Pattern 5</u>
	Firm A for 1 Year	Firm A for 2 Years	Firm A for 3 Years	Firm A for 4 Years	Firm A for 5 Years
<i>Probability of Pattern</i>	30%	21%	15%	10%	24%
<i>Year 1 Employer Firm:</i>	A	A	A	A	A
<i>Year 2 Employer Firm:</i>	B	A	A	A	A
<i>Year 3 Employer Firm:</i>	B	B	A	A	A
<i>Year 4 Employer Firm:</i>	B	B	B	A	A
<i>Year 5 Employer Firm:</i>	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:

	<u>Pattern 1</u>	<u>Pattern 2</u>	<u>Pattern 3</u>	<u>Pattern 4</u>	<u>Pattern 5</u>
	Firm A for 1 Year	Firm A for 2 Years	Firm A for 3 Years	Firm A for 4 Years	Firm A for 5 Years
<i>Probability of Pattern</i>	30%	21%	15%	10%	24%
<i>Year 1 Salary:</i>	\$142,466	\$142,466	\$142,466	\$142,466	\$142,466
<i>Year 2 Salary:</i>	\$90,000	\$142,466	\$142,466	\$142,466	\$142,466
<i>Year 3 Salary:</i>	\$90,000	\$90,000	\$142,466	\$142,466	\$142,466
<i>Year 4 Salary:</i>	\$90,000	\$90,000	\$90,000	\$142,466	\$142,466
<i>Year 5 Salary:</i>	\$90,000	\$90,000	\$90,000	\$90,000	\$142,466
<i>Total 5 Year Income:</i>	\$502,466	\$554,932	\$607,398	\$659,864	\$712,330
<i>Annual Average:</i>	\$100,493	\$110,986	\$121,480	\$131,973	\$142,466

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 = Prob₁ x Avg₁ + Prob₂ x Avg₂ + Prob₃ x Avg₃ + Prob₄ x Avg₄ + Prob₅ x Avg₅

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

\$119,099

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: **30%**
- (3) Your annual salary during any year that you are employed by Firm A will still be equal to: **\$142,466**
- (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: **\$90,000**

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: \$135,000

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**APPENDIX D. SECOND-PRICE SEALED BID AUCTION
INDIVIDUAL CHOICE EXPERIMENT SECOND SALARY SURVEY
- BELOW 50TH PERCENTILE**

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

Distribution of New Salary Requests to Firm A

The <i>lowest</i> 5-year annual salary request submitted among the other Firm A employees was:	\$40,000
The <i>highest</i> 5-year annual salary request submitted among the other Firm A employees was:	\$100,000
The <i>45th highest</i> 5-year annual salary request submitted among all Firm A employees was:	\$129,517

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:	\$129,517
Year 2:	\$129,517
Year 3:	\$129,517
Year 4:	\$129,517
Year 5:	\$129,517
Total:	\$647,586

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 \$450,000 of experimental income = \$1 of actual earnings

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APPENDIX E. SECOND-PRICE SEALED BID AUCTION INDIVIDUAL CHOICE EXPERIMENT SECOND SALARY SURVEY – ABOVE 50TH PERCENTILE

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: **\$40,000**
 The *highest* 5-year annual salary request submitted among the other Firm A employees was: **\$100,000**
 The *45th highest* 5-year annual salary request submitted among all Firm A employees was: **\$130,867**

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: **30%** 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: **\$142,466**
 Each year that you work for Firm B, your annual salary will be: **\$90,000**

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:	\$142,666
Year 2:	\$142,666
Year 3:	\$90,000
Year 4:	\$90,000
Year 5:	\$90,000
Total:	\$554,932

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 \$450,000 of experimental income = \$1 of actual earnings

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