

A Market Approach to the Labor Allocation Problem: The Use and Valuation of Job Incentives *

Tanja F. Blackstone, Ph.D.
Navy Personnel Research and Development Center
5722 Integrity Drive
Millington, TN 38054-5035
Ph: (901) 874-4642
DSN: 882-4642
Fax: (901) 874-2720
email: blackstn@nprdc.navy.mil

Peter M. Williams, Ph.D.
University of North Alabama
Ph: (256) 765-4315
Email: pmwillia@unanov.una.edu

Mark Van Boening, Ph.D.
University of Mississippi
Economics Department
Holman Hall
University, MS 38677
Ph: (601) 232-5841
email: vanboen@bus.olemiss.edu

All errors are solely those of the authors. Please do not quote or reprint without permission.

A Market Approach to the Labor Allocation Problem: The Use and Valuation of Job Incentives

"The whole of the advantages and disadvantages of different employment of labour and stock must, in the same heighbourhood, be either perfectly equal or continually tending to equality. If in the same neighbourhood there was any employment either evidently more or less advantageous than the rest, so many people would desert into it in the one case, and so many would desert it in the other, that its advantages would soon return to the level of other employments. This at least would be the case in a society where things were left to follow their rational course, where there was perfect liberty and where everyman was perfectly free both to choose what occupation he thought proper, and to change it as often as he thought proper."

Adam Smith, *The Wealth of Nations*

1. Introduction

Adam Smith's recognition of the non-pecuniary elements of employment, the whole of the advantages and disadvantages, gave rise to the modern theory of *compensating wage differentials*. Referring to the combination of both explicit payments of currency wages and the working conditions, which affect worker utility, Smith indicated that an equilibrium condition would tend to occur across different employments. However, the existence of a single money wage would not necessarily be the norm. For those jobs, which involve particularly unpleasant working conditions, a higher wage would be required to compensate for the extra disutility of those unpleasant conditions. Likewise, for those jobs that involve some utility enhancing conditions, some workers will accept a lower wage in return for the extra utility involved in the job.

Furthermore, Smith's theories on the effects of free exchange between individuals lead to other theories about the pattern of outcomes for society as a whole, specifically the issue of efficiency.

The efficiency results of the Invisible Hand Theorem were not rigorously proven with the power of pure mathematics until the work of Nobel Laureate Gerard Debreu and Lionel McKenzie in the 1950's. Since that time, the modern name has become the First Fundamental Theorem of Welfare Economics (Landsburg, 1993). One crucial mechanism in the exchange mechanism is the operation of prices both as signals and as incentives. After establishing the existence of an efficient allocation of resources from competitive forces using the First Fundamental Theorem, there is another result from the Second Fundamental Theorem, which shows the existence of multiple efficient allocations, and that any of those efficient allocations can be achieved by first redistributing income in an appropriate way, and letting competition, trade, and prices function freely (Landsburg, 1993).

The efficient allocation of labor in society is a laudable goal, but the theoretical proof of its existence does not guarantee that it will be attained in the imperfect world in which we live. Unfortunately, the rigorous proofs of the efficient outcomes involve necessary conditions, which do not exist in all employment markets. For those employment markets that do not meet the necessary conditions for market-based efficiency, and therefore may be inefficient, there remains the question of whether some specific changes in the market structure may increase efficiency. Within the context of that question, we propose the use of the experimental economics research method to investigate the impact of proposed market based allocation of labor *within* a large firm where the necessary conditions are not fully met.

There is a significant body of research that has used auctions in an experimental laboratory setting to test basic theories of supply and demand, resource allocation and profit maximization.

In general, previous research has sought to test standard economic theory regarding the use of prices as the means to facilitate optimal allocation of resources.. Unlike previous work, this research uses a flexible pricing mechanism, as opposed to centralized decision making to investigate the possibility of efficient allocation of labor within a large employer's workforce.

This research expands the body of experimental economic research by applying microeconomic theory to a special market case, that is of using implicit prices to price job attributes. Further, this research allows the Navy to ascertain the benefits of using a market setting as a means to allocate labor resources; an area of significant interest to the Navy.

2. Navy Problem/Deficiency

Assigning approximately 130,000 Sailors a year requires over 200 detailers in the Bureau of Personnel. The vast majority of personnel assignments are determined by negotiation between the detailers and Sailors over the phone. Much of the discussion between Sailor and detailer is merely identifying the available and appropriate jobs based on the Navy's needs and the Sailor's preferences. Enlisted detailing is often time-consuming, inefficient, and ineffective.

While detailers try to consider the needs of the Sailor the fact remains that the enlisted detailing process is primarily demand-driven; that is, billets must be filled in order to insure a smooth operating tempo. The current distribution and assignment system, whereby the detailer-Sailor negotiation process favors the Navy, lends itself to reduced retention rates, gapped billets - particularly in less desirable jobs - in effect, a broken distribution system.

In an effort to increase retention and induce individuals to volunteer for less desirable jobs, the Navy has adopted numerous incentive systems, such as selective reenlistment bonuses and reduced sea-shore rotation. The result of these incentive structures has been mixed; highly skilled individuals continue to abandon their Naval careers in favor of more desirable private

sector jobs. The cause of low retention, however, cannot solely be attributed to the gap in military-civilian wages. Frequent moves, consistent rotations to undesirable jobs or locations, and family constraints (such as a spouses' employment opportunities and school quality) factor into a Sailor's decision to leave.

Low retention rates further exacerbate the current distribution and assignment problems faced by the Navy. There are fewer experienced Sailors to fill critical sea and shore billets. The results are longer sea duty tours, longer working hours, and a reduced quality of home life. All of these contribute to the falling retention rate.

The current incentive systems used by the Navy to combat low retention and unmanned billets are fixed, all or none offers, and targeted to specific ratings. A fixed bonus is offered to individuals in pre-determined ratings to induce reenlistment. What is not known prior to the enlistment decision is if the bonus offered is sufficient to induce reenlistment or if the individual would have reenlisted in absence of the bonus. In either case, the Navy incurs substantial costs. Further, the Navy may be losing highly-skilled Sailors who, while not eligible for a bonus under the existing incentive structure, could have been induced to reenlist if offered a bonus.

3. Research Objective

The efficient allocation of scarce resources is a fundamental problem in economics. Regardless of the type of market, (the factor market or the goods market) and institutional constraints, the private sector uses prices to allocate scarce resources across competing uses. Prices rise and fall in response to demand and supply and under the assumption of a competitive market the interaction of buyers and sellers will result in a market-clearing price.

The labor market works in a similar manner. Wages, instead of prices, are used to allocate labor across competing uses. Employers buy labor and the price of that labor is the wage. Employers have every incentive to offer the lowest wage necessary to acquire labor. In contrast, workers have an incentive to sell their labor for the highest possible wage. Employers offer a wage which workers either accept or reject. If workers accept the wage offer, the market clears, that is the supply of labor just equals the demand for labor. If workers reject the offer, the employer must increase the wage offer. Again workers either accept or reject the offer. This process continues until the labor market clears.

In the case of tight labor markets the employers and employees negotiate not only on the wage rate but also on various job attributes such as bonuses, office location, support staff, vacation time and promotions. Many firms use job attributes or incentives to induce individuals to stay with the firm. The combination of wages and incentives serve two purposes: (1) they compensate the employee for the opportunity cost of foregone leisure and (2) wages and or incentives can be used as a tool by the employer to compensate the employee for any negative job characteristics. For example, employers might offer increased vacation time to compensate the employee for separations from his family that can be attributed to work related travel. The ability of private sector employers to offer individually tailored wages and incentives increases the qualified applicant pool, facilitates the job matching process and increases employee retention.

Unlike the private sector the Navy cannot offer individually tailored compensation packages. Institutional constraints mandate that the Navy pay Sailors of equivalent paygrade and length of service equivalent wages. The Navy can, however, negotiate, that is offer incentives, on various job attributes, such as bonuses, reduced sea-shore rotation, and promotion points, for example.

What follows is an approach of pricing job attributes (job incentives) in a market setting such that Sailors are efficiently allocated across jobs.

B. Approach

The objective of this research is to ascertain (1) how valuing job attributes (incentives) can induce the Navy and Sailors to reveal their true reservation prices, and (2) how a market mechanism can allocate scarce labor resources efficiently, that is placing the right Sailor in the right job at the right time.

Basic Model

Consider a market with one seller (the Navy) and many buyers (Sailors). The seller and buyers bid, not on a good (or job), but on attributes of the job. It is assumed that all the job attributes to be considered in the model are positive attributes and therefore, the values assigned to each attribute can be considered an incentive.

For simplicity only three job attributes are considered, such as bonus amount, number of months between sea-shore rotations, and promotion points. Unlike a typical labor market the seller knows that the job will be filled regardless of the incentives offered. The seller's objective, however, is not only to fill the job, but to increase retention, and the efficient distribution of Sailors. The seller, therefore, is not selling a job, he is selling the attributes of the job.

When a job becomes vacant the seller announces to the market what incentives he is willing to offer to fill the vacancy. For example, this may be \$500 in bonus money, 5 weeks fewer of sea duty, 5 points towards promotion.

All buyers in the market observe the seller's offer. The offer is either rejected by all buyers in the market, accepted by 1 buyer or accepted by more than 1 buyer. In the case where the seller's

offer is accepted by 1 buyer, a match is made, the job is filled on mutually agreeable terms and the market closes.

In the case where there are numerous buyers, buyers make counteroffers, such that the counteroffers are lower in value than the offer made by the seller. The buyer's offers are posted in the market. The seller accepts the lowest offer and the market closes. An important aspect of this scenario is that the initial offer made by the seller was too high. A market mechanism facilitates the process of obtaining workers at the lowest possible price.

In the final case where all buyers reject the seller's offer, buyers post counteroffers, where the counteroffers exceed the value of the seller's initial offering. The seller either accepts an offer and the market closes or rejects all offers and posts a new offer. Successive offers and counteroffers are made until an offer is accepted and the market closes. An important aspect of this scenario is that the initial offer made by the seller was too low. By allowing buyers (Sailors) to reveal the amount of incentives necessary to induce them to accept a job facilitates increased retention and efficient distribution of manpower.

It is important to note that the seller has an incentive to offer incentives just necessary to induce the buyer to accept his offer and conversely the buyer has an incentive to require incentives with infinite values. A constraint imposed on the seller is that the sum of the values of the incentives cannot exceed some fixed amount. This serves two functions, buyers cannot ask for or expect infinite incentives and the market converges relatively quickly to equilibrium. Buyers and sellers have full information as to the distribution of incentive values and offers and counteroffers are made in light of the constraint.

It is theoretically possible that the market will not converge, that is no buyer will accept an offer made by the seller. This is likely to be particularly true for highly undesirable jobs. In order to

facilitate convergence in the market an additional constraint is imposed; a limited number of offers and counteroffers can be posted. If the market does not converge then a buyer is randomly selected to take the job.

Treatment Variables

- a. The job attributes in the basic model considers only positive job attributes, ignoring how negative job attributes affect the Navy offer and Sailor's counteroffer. Negative attributes will be incorporated into the model to ascertain their affect on the valuation of positive job attributes.
- b. In the basic model the Seller's (the Navy) offers are determined by a set of rules. Under certain circumstances it may be preferable to have an actual human seller, where the rules are defined but where strict adherence may or may not occur. This research effort will examine the rules versus human performance of the market.
- c. The basic model focuses on market exchange in the case where the Sailor is evaluating and bidding on the attributes of a single job. An extension of the basic model is to observe the market dynamics by allowing Sailors to evaluate and bid on the job attributes of 2 or more jobs.
- d. The basic model assumes that all Sailors (Buyers) in the market cannot opt out of the market, that is leave the labor market (leave the Navy). The research will examine how an in/out option affects the incentive offers and counteroffers.
- e. The basic model assumes that the sum of the incentives offered by the Navy is fixed; the value of individual attributes can vary, but the sum of the total is a fixed value. This fixed sum imposes a constraint on the Navy that may result in possible market inefficiencies. To

test this hypothesis the constraint will be relaxed, allowing some flexibility in the total valuation of the incentive offers.

C. Methodology

Empirical research in economics has typically been limited to field studies that use data from the naturally-occurring economy, e.g., stock market prices or consumer spending patterns. Over the past three decades, laboratory methods have been accepted as an alternative means of generating data and evaluating economic theory. What follows is a discussion on experimental economics, details of a general experiment, and precepts needed to conduct valid laboratory experiments.

The basic experimental economics methodology is to create an artificial, controlled, and monitored environment that is homomorphic to a naturally-occurring economic institution.

Subjects are allowed to interact in that institution making any decisions that are in their best interest. For example, a subject may be a buyer in a market, and lower buying prices would mean greater profit for the subject. The subject would have to decide at which price he/she is willing to buy. At the end of the experimental session, the subjects are paid whatever earnings accrued to them from their decision. Details of each aspect of the methodology are discussed below.

a. Subjects: Experimental subjects are typically recruited from undergraduate business courses. They are told that (a) an experiment is being run and the amount of time that the market is likely to take, (b) if they volunteer to participate they will be paid a show-up fee, and (c) they will have the opportunity to make more money in the experiment. It is explained that no amount of money is guaranteed, as it depends on the decisions made by a subject.

- b. Payoffs: As mentioned above, subjects are paid a show-up fee. In addition, subjects are paid the amount of money they earn in a specific experiment. These payoffs are designed to aid the subject in making salient decisions. Average payoffs are \$5-\$8 dollars per hour, but may range from \$0 to \$100, depending on the experimental design. If subjects make bad decisions during an experiment such that earnings are negative, they keep their show-up fee, but are paid nothing for participating in the market.
- c. Names: Subjects are asked to identify themselves as they begin the instructions, so that they can be identified when payments are made. Also, upon receipt of their final cash payments, subjects are asked to sign a receipt form, and give an identification number in order to maintain records of cash disbursements. The names are not recorded with the decision data and no other use is made of the names other than for payment and accounting purposes.
- d. Instruction: Prior to each experiment, subjects go through extensive instructions that explain how the experiment works and how they will be able to make money. Typically the instructions contain several examples of the kinds of decisions that a subject will be asked to make. Subjects are allowed to take as long as necessary to complete the instructions and are encouraged to ask questions throughout both the instruction period and during the experiment.
- e. Privacy: All decisions made by the subjects are private and subjects are not permitted to talk to each other during experiments. (There are rare instances where subjects participate in groups to make decisions. In those instances, no threats or side payments are allowed. The experimenter closely watches the group to ensure that

the rules are followed.) Payments at the end of the experiment are made individually and privately.

f. Deception: Extreme care is taken never to deceive the subjects in any way. It is essential to the development and analysis of theory that each subject believes that if they are told something about the experiment, then it is absolutely true. This does not mean that everyone is told everything about every experiment. Just as with naturally occurring markets, for example, there are times when a person has incomplete information. However, they are strongly encouraged to believe that everything they are told is true.

The validity of experimental research in economics is founded on the concept of *induced value*. Real people must make real decisions about objects or activities that have real value to them. Control is the essence of experimental methodology, and it is critical that the experimenter control or specify individual values so that he/she can state that values do or do not differ in a specific way. Generally speaking, laboratory experiments in economics presume that decision-makers are autonomous, own-reward maximizers. The four precepts behind the concept of induced value are nonsatiation, saliency, dominance and privacy. These precepts are described below.

g. Nonsatiation: Given a costless choice between two alternatives, identical except that the first yields more of the cash reward than the second; the first will always be chosen (i.e. preferred) over the second by an autonomous individual. An economist would say utility is a monotone increasing function of the cash reward.

h. Saliency: The cash rewards in an experiment should have motivational relevance. Subjects are guaranteed the right to claim a reward; , this increases the good outcomes, and

decreases the bad outcomes. That is, some decisions have higher rewards than others and the mapping of decisions into rewards is well-defined and consistent.

Not all cash rewards are salient. For example, a flat fee is often used to compensate subjects for participating in psychology experiments. This type of reward is nonsalient; it is a flat fee that is independent of the decisions made by the participant. The cumulative earnings of a subject over the course of an economics experiment are salient, as they are based on experimental outcomes and will vary as the subject's decisions vary.

i. Dominance: To ensure that control over preferences for the cash rewards is maintained, the reward structure must dominate any subjective costs (or values) associated with participation in the activities of an experiment.

All individual actions have subjective costs, even simple tasks like pressing keys on a computer keyboard. For example, suppose a subject was repeatedly asked to press either the ENTER key or the BACKSPACE key. Paying the subject \$0.01 each time she presses the ENTER key and \$0.02 she presses the BACKSPACE key would be a salient reward in a medium in which the subject is nonsatiated. A simple theory might predict the subject would always press the ENTER key and never the BACKSPACE key. But such a trivial payment may not be sufficient to dominate the subjective costs of the exercise; the subject might sometimes press the BACKSPACE key simply to relieve boredom.

Similarly, the complexity of the task must be considered. Activities that require extensive thought or calculations might be compensated appropriately,

independent of nonsatiation and saliency. The discussion of saliency above refers to the choice between two costless alternatives.

j. Privacy: Each subject in an experiment is given information only on his/her own payoff alternatives. Individuals may bring egalitarian, altruistic, or such other preferences from everyday social life into the laboratory. Thus a participant's valuation of the reward medium will be interdependent of the rewards which others receive. This would result in a loss of control, as well-defined valuations may not be induced and individuals would not be autonomous, own-reward maximizers.

In economics experiments, cash rewards are designed so as to compensate subjects not only for their participation (i.e., achieve dominance), but also to compensate them for their opportunity cost (e.g., time that could be spent in the pursuit of leisure, knowledge, other income). A rule of thumb, the 'going wage rate' for a typical person in the subject pool is used as the benchmark.

4. Job Market Labor Allocation Model

The Job Market and Labor Allocation Model (JMLAM) was designed and developed as a software prototype to serve as an 'information broker' between sellers (Sailors, who are sellers of labor) and a buyer (Detailer or fair broker, who is a buyer of labor). JMLAM attempts to model a flexible incentive system where sellers and a buyer reveal his or her valuation of various job attributes using a competitive market setting.

JMLAM provides a bidding or auction environment that allows a single buyer and multiple sellers to participate in a market setting. The system provides the a great deal of flexibility in

that the user can choose (1) from different auction rules (first price and a modified second price auction), (2) up to three attributes or templates, (3) the auction parameters, and (4) from a list of Naval occupations or a hypothetical good. JMLAM is designed to allow researchers to observe behavioral outcomes of subject interactions in a multi-attribute incentive environment.

a. JMLAM Model Specifications

The Job Market Labor Allocation Model is designed to provide a bidding environment where a buyer and multiple sellers can submit offers and or counteroffers on the attributes of a hypothetical good. The model is designed to allow flexibility for experimental testing, where the buyer and sellers can interact in an auction environment.

The experimenter or superuser sets the session, auction, buyer and seller's parameters.

Parameters include auction rules, number of sellers, reservation prices, maximum number of bidding rounds allowed per auction, time constraint, type of job (hypothetical or otherwise), number of attributes, userids, passwords, and the exchange rate. It is important to note that each session consists of one or more auctions and an auction can consist of one or more rounds.

Auctions always consist of one buyer and at least one or more sellers. Once the superuser has set all the required parameters, an auction can be initiated. The buyer always initiates auctions.

Auction rules consist of either a first priced auction or a modified second price auction. The winning bid in the first price auction is the lowest bid for all three attributes. The winning bid in a second price auction is the bid with the lowest A1 value. However, the seller receives earnings based on the second lowest feasible bid. Calculation of the winner's earnings (seller) and the buyer's earnings under the separate auction rules are discussed in the instructions.

The auction is designed so that each seller can sell a single unit of a hypothetical good, while the buyer can purchase one or more units of the good. Therefore, it is necessary that the number of sellers who participate in an auction exceed the number of units that the buyer need to purchase. It is important to note that for purposes of experimental testing /observing of behavior and market outcomes jobs are assigned generic names and the incentive attributes are referred to as templates or attributes. This is done in order to prevent individuals from bringing in egalitarian, altruistic or other preferences from everyday social life into the experiment. However, the superuser function will allow you to change the generic names and incentives to specific job titles, locations and/or incentives.

b. Design Limitations

A possible weakness in the current system is that sellers may tend to accept/submit offers based on the summation of the values of the attributes and not accept/submit offers based on the individual valuation of each attribute. The researcher is interested in capturing the sellers/buyers marginal rates of substitution between the three attributes. There is no automation in the current system to capture this information. Procedures for manually capturing marginal rates of substitution may or may not be feasible given the limitations of the current design.

Another potential adverse behavioral result may occur in the case of second price auctions. Sellers may make counter offers that maximize the probability of winning and not the joint objective of maximizing earnings and the probability of winning. For example, sellers could bid their reservation price on the first attribute and bid substantially higher on the other attributes. In pilot tests of the system this behavior has not been observed.

c. Progress to date

Pilot tests of JMLAM have been conducted at the University of North Alabama and with Department of Defense civilian personnel.

References:

Landsburg, Steven E., 1993, The Armchair Economist, The Free Press, New York, New York