LABOR MARKET SEARCH: AN EXPERIMENTAL STUDY

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The theoretical results derived from models of economic search have implications which relate to the structure and performance of labor markets. Utilizing a series of laboratory experiments, we attempt to capture many of the features of workers' search and also the conditions under which labor markets operate. By varying certain of the experimental conditions, we are able to determine the searchers' responses to changes in the terms of unemployment insurance, to the existence of a minimum wage, and to different states of information about the underlying distribution of wages. In most cases the behavior of the searchers is consistent with that predicted by theory.

The economic theory of search has become a topic of intense interest over the past ten years. The questions which have been investigated have implications for the definition of the natural rate of unemployment, the position of the Phillips curve, the impact of unemployment insurance, and a variety of other labor market policy questions. Despite the importance of this literature, many of the theoretical results remain untested.

In an earlier article (Schotter and Braunstein, 1981) we reported a series of laboratory experiments which test a number of hypotheses derived from the theoretical search literature. These results show that the searchers in our experiments behave in a manner that is consistent with the optimal reservation wage search strategy. This paper presents further results not reported in that paper, all of which have parallels in more applied and policy-related questions.

The results we report cannot be expected to be (or should not be) the basis upon which social policy is made. Rather they should be taken as the outcome of one set of experiments that may be consistent with the way things work in the real world and require replication elsewhere before they become the basis for policy decisions. In any case, we believe that experimentation in economics is mainly of use when applied to testing well-established theoretical results as opposed to furnishing a basis upon which to make policy prescriptions.

Section I begins with a short description of the Basic Search Paradigm — an abstraction which depicts the most basic search situation — and then states the hypotheses to be tested. Section II describes the experimen-

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tal design used to test these hypotheses. Our results and conclusions are then presented in sections III and IV, respectively.

Before we start, it is worth repeating that, to a great extent, the inspiration for these experiments comes from the two-part survey by Lippman and McCall (1976). The policy-related questions we investigate were influenced by part II of their survey.

I. THE BASIC SEARCH PARADIGM AND SPECIFIC HYPOTHESES TESTED

The Basic Search Paradigm of the theory of optimal economic search used by us to devise our experimental design, is based upon the following set of stylized facts: A worker looking for a job cares only about the wage of the job — no other characteristic is important. Each day he searches and generates one and only one job offer from a stationary distribution that he knows. He can search as many times as he likes (infinite horizon) and once he receives an offer it is always available (perfect recall). Each time he searches he incurs a constant search cost of c, and he is assumed to be risk neutral.

As we have previously stated (Schotter and Braunstein, 1981), these characteristics — perfect knowledge of the wage distribution, constant search costs, infinite horizons, perfect recall, risk neutrality, etc. — furnish us with the archetypal search situation for the literature which has developed by relaxing these characteristics and investigating how the optimal behavior of the searcher should change. This behavior may be viewed as "myopic" because it is characterized by the existence of an optimal reservation wage. If the conditions of the Basic Search Paradigm hold, it is optimal for a searcher to set a reservation wage ϵ and to continue searching as long as the wages he is offered are less than ϵ, but to stop as soon as he receives a wage of ϵ or greater. The rule is myopic in that all a searcher need do is compare his most recent offer to ϵ and follow the dictates of the strategy.

The hypotheses that we test compare the behavior of our searchers before and after a change is made in the Basic Search Paradigm. Since the theory predicts the effects of these changes, we test the behavior of our subjects in the light of the theory.

A. Unemployment Insurance. Our first area of inquiry involves unemployment insurance. The effect of unemployment insurance on the duration of unemployment continues to be debated. [For one overview of this subject, see Marston, (1975).] To develop our hypotheses formally, we first characterize unemployment insurance as a temporary subsidy to the searcher which reduces his cost of search for its duration. This characterization produces two related hypotheses.

Hypothesis 1: Unemployment Insurance. When a searcher searches in the Basic Search Paradigm and knows that his first $\underline{k}$ searches are subsidized, he will tend to search longer, accept a higher wage, increase his reservation wage, and be more selective with respect to wages than a searcher who is searching under identical circumstances without the $\underline{k}$ period subsidy.

A second issue that is raised in the literature is whether or not searchers exhaust their benefits before accepting or even looking for a new job. This question is important when unemployment benefits are approximately equal to the wages of the worker's previous job.

Hypothesis 2: Exhaustion of Benefits. Workers who search with recall in the basic Search Paradigm and whose first $\underline{k}$ searches are subsidized will tend to refuse any job until period $t = k$.

B. Minimum Wage. Possibly one of the most emotional economic and political issues of the past twenty-five years has been minimum wage legislation. We focus on the question of whether minimum wages tend to increase the duration of search unemployment for those workers who are affected by characterizing minimum wage legislation in terms of the search model. Assume that in the absence of a minimum wage a worker searches from a stationary symmetric triangular wage distribution defined over the interval $a \leq w \leq b$. The presence of a minimum wage truncates the distribution at some $\overline{a}$, $< a < \overline{a} < h$ (h is the mean of the distribution), such that all wages less than $\overline{a}$ cannot (by law) be offered. Consequently, the searcher knows that he will never be offered a wage less than $\overline{a}$. We can then ask whether this truncation, resulting from the imposition of a minimum wage, increases the expected number of periods of search as well as the reservation wage, the average accepted wage, etc.

Hypothesis 3: Minimum Wage. If a worker in the Basic Search Paradigm searches from a wage distribution $F(w)$ defined over the interval $a \leq w \leq b$, and if the distribution is truncated at the lower end, then the searcher tends to set a higher reservation wage, search longer, and be more selective of wages than a worker under identical circumstances but whose wage distribution $F(w)$ is not truncated.

C. Information and the Labor Market. Labor market policy has been concerned for a long time with facilitating the exchange of information within the labor market. One interesting result in the search literature deals with the robustness of the optimal search rule. Gastwirth (1976) demonstrates that, while the myopic reservation wage rule maximizes expected income when the searcher is fully and correctly informed about the exact wage distribution from which he is searching, if the distribution is misspecified and gives the searcher a mistaken impression as to what the

real distribution is, the reservation wage rule may lead to inappropriate and inefficient behavior.[1] In addition to the effects of different states of knowledge on the reservation wages and number of searches for each subject, we examine the subjects' payoffs to determine if it is worthwhile for searchers to pay to get better information. The results of this test may indicate whether the private benefits of increasing information in markets are greater than the private costs.

> *Hypothesis 4: Robustness of Search Strategy.* Workers who think that they are searching with a constant search cost of c from a wage distribution $F(w)$ with density function $f(w)$ and an associated optimal reservation wage of E_F but are actually searching from a distribution $G(w)$ with density function $g(w)$ whose associated optimal reservation wage is E_G with $E_G < E_F$, tend to search longer than they would if they had known that they were searching from $G(w)$ and receive final payoffs which are worse than they would receive if they had known from the beginning that they were searching from $G(w)$.

Another related issue was raised by Telser (1973) who found that the additional payoff that resulted from searching optimally was negligible when compared to a naive rule in which the searcher merely accepted the first wage offered him. He interpreted this result as indicating that the return from optimal search could be quite low. Although we cannot test Telser's hypothesis directly, we test a closely related question. First, if we assume that our agents used a variety of different search strategies,[2] then if there were no meaningful payoff differences attributable to those strategies (as Telser's results would lead us to believe), we would expect that the variances in the payoffs that we observe should be quite low. In addition, we investigate whether the profitability of various types of searching strategies depends on the informational states of the search. For instance, the variance in the payoffs when searchers are fully informed about the distributions from which they are searching can be compared with the variance when they are searching from either a misspecified distribution or an unknown distribution.

> *Hypothesis 5: Low Payoff Variance.* The variance of payoffs of searchers in the Basic Search Paradigm is low relative to the mean of the payoffs.

> *Hypothesis 6: Effect of Information on Payoff Variance.* The variance of payoffs of workers searching from identical distributions is greater when they are not informed at all about the distribution of wages than in a situation where they are fully informed.

1. See the related hypotheses and tests (9 and 10) in our earlier paper.

2. This assumption is not necessarily inconsistent with the results of our earlier tests which simply indicated that, *as a group*, subjects behaved as if they were searching optimally. Within each group, behavior could have been, and was, quite varied.

Hypothesis 6, if true, implies that even if there is no benefit from using different search strategies when searchers are fully informed about the underlying distribution of wages, there may indeed be benefits when searchers are not so fully informed.

II. EXPERIMENTAL DESIGN

A complete explanation of our experimental design may be found in Schotter and Braunstein (1981).[3] We present only a brief summary here. Student subjects are each given ten pages of instructions which explain both the nature of optimal search and the fact that they are to engage in experimental search trials, some of them identical to each other, but most of them different. They are told that the instructions will be explained in detail by the principal investigator and that a 30-minute practice period precedes the actual experiment.

Each subject is told that he will participate in an experiment designed to investigate how people search for wages and prices. He is told that if he wishes, he can think of himself as a worker looking for a job; and that the wage is the only characteristic of interest to him. The exact wages existing are not known with certainty but rather are random and are described by some probability distribution (which will be disclosed in advance). Consequently, in order to obtain a satisfactory wage, the subject must search; though each time he searches he incurs a cost. The final payoff to him consists of the wage accepted minus the total search costs incurred.

The actual searching procedure is quite simple. The student sits in front of the computer terminal and, types the word "SEARCH" into the terminal to begin. The computer offers the student a wage by typing "$\underline{w}$ is my offer," where $\underline{w}$ is some wage derived from a specific probability distribution which the searcher always knows (or at least thinks he does). The students are assigned randomly to one of three groups, each of which is engaged in a number of separate trials. In these trials (from eight to twelve, depending upon the group) the conditions are designed to represent the salient features of the specific hypotheses.[3]

Payoffs are made in points, and these points are then converted into dollars by formulas which depend upon the group to which the subject was assigned. There are two aspects of the experimental design which must be emphasized here. First, we obtain information on each searcher's actual, as opposed to stated, reservation wage by recording both the wage offer he accepts and the highest of the wage offers that he rejects during each trial. The "accepted wage" and "highest rejected wage" should, we expect, bound the actual, but unobservable, reservation wage from above and below, respectively. Secondly, searchers in two of the

3. In the discussion of the results that follow and in the tables, references to experimental subject groups and search trial numbers refer to the groups and trials described in the experimental design section in Schotter and Braunstein (1981).

groups are paid one penny for each point of profit earned, while searchers in the other group have their points converted into dollars by means of a concave function. This concave function has the effect of making the latter group relatively more "points risk averse" than the two other groups.

III. RESULTS

Hypothesis 1: Unemployment Insurance. To test the impact of our simulated unemployment insurance, we compared the behavior of searchers in the trials before and after a five-period subsidization of the search cost. In the "control" trial the cost per search is set at five points each; however, for the "experimental" trial there is a three-point subsidy for each of the first five searches. This subsidy has the effect of lowering the search cost to two points for five periods, after which the cost per search returns to five points.

The results are generally as expected and are quite similar to those we found previously in a test of the effects of changes in search costs, (See Schotter and Braunstein, 1981).[4] In trials where "unemployment insurance" reduces the costs of early searches, the subjects search longer on average. This is true for both risk neutral and risk averse groups and is statistically significant in both cases. Furthermore, both groups set higher average reservation wages when the insurance is in effect (See Schotter and Braunstein, 1981, for an explanation of how average reservation wages were calculated.) But the statistical significance of these differences varies, and the findings with respect to the average highest rejected wage and average accepted wage are inclusive. The results are presented in table 1.

Notice that the searchers who were in the risk averse group were affected more by the imposition of unemployment insurance. For instance, they tend to search an average of 4.71 times which is significantly greater than their risk neutral counterparts. This stronger reaction from risk averse searchers is as expected since the concavity of their simulated utility functions means that in utility terms their search costs are more greatly reduced than the search costs of the risk neutral searchers.

Hypothesis 2: Search Duration and Exhaustion of Benefits. In testing Hypothesis 2 we are interested to see whether the institution of unemployment insurance tends to extend the average duration of search until benefits are exhausted. We tested the hypothesis that the average search duration for both risk neutral and risk averse searchers (under a system of unemployment insurance) was five periods. Using the data presented in table 1, we see that the mean search duration of the risk neutral searchers with unemployment insurance is 3.80 searches compared to 2.70 without, while the mean for the risk averse searchers is 4.71 as opposed to 3.33. When we test the hypothesis that these durations were equal to five, we

4. Specifically see Hypothesis 4 in our earlier paper.

TABLE 1

Tests of H^1 (Unemployment Insurance)

Group and Parameter Tested	Condition: Without Unemployment Insurance	Condition: With Unemployment Insurance	Difference
Risk Neutral:			
Reservation Wage	134.50	140.00	5.50
Highest Rejected Wage +	123.17	107.42	-15.75
Accepted Wage	146.45	148.88	2.43
Number of Searches	2.70	3.80	1.10*
Risk Averse:			
Reservation Wage	109.71	123.52	13.81*
Highest Rejected Wage +	107.27	125.80	18.53*
Accepted Wage	141.40	135.86	-5.54
Number of Searches	3.33	4.71	1.38*

*Significant at the 95% level.

\+ The "highest rejected wage" statistics reported here represent the average highest wage rejected by all searchers in a given trial before they accepted a wage. They are presented in an effort to present an operational and observable statistic with which to measure the reservation wages of our searchers.

find that both 4.71 and 3.8 are not significantly different from 5.0 at the 99% level of significance. Consequently, in our experiment a simulated system of unemployment insurance does extend significantly the search duration to a length not significantly different from the period in which benefits were exhausted.

Hypothesis 3: Minimum Wage. The tests of Hypothesis 3 compare results from two experimental trials in which all conditions are similar except that the distribution of wage offers is symmetric triangular (over the range 0 to 200) in one trial and truncated symmetric triangular in the other. In the truncated distribution, all wage offers below 50 points are suppressed. For this reason we consider this set of trials to be a reasonable simulation of some aspects of a minimum wage standard although we do have reservations which we indicate below.

The results shown in table 2 are mixed. Both the risk neutral and the risk averse groups set higher reservation wages when facing a minimum wage, but the average highest rejected wage and average accepted wage are higher only for the risk averse group. Furthermore, in most of the comparisons the differences are not statistically significant. We find similarly mixed results in the comparisons of average number of searches. The risk neutral group searches, on average, a significantly longer time with the minimum wage than without it. However, the difference in the risk averse group is not statistically significant and has the opposite sign.

TABLE 2

Tests of H^3 (Minimum Wage)

Group and Parameter Tested	Without Minimum Wage	With Minimum Wage	Difference
Risk Neutral:			
Reservation Wage	134.50	150.00	15.50*
Highest Rejected Wage	123.17	115.31	-7.86
Accepted Wage	146.45	142.23	-4.22
Number of Searches	2.70	4.10	1.40*
Risk Averse:			
Reservation Wage	109.71	118.76	9.05*
Highest Rejected Wage	107.27	127.71	20.44*
Accepted Wage	141.40	155.94	14.54
Number of Searches	3.33	2.62	-0.71

*Significant at the 95% level.

Our method of simulating a minimum wage has two drawbacks. Firstly, on a statistical basis, by truncating the distribution we change the mean and the variance of wages actually offered; consequently, the results we obtain may be merely a response to the higher mean of the relevant legal wage distribution and not to the minimum wage itself. The second is institutional; our design embodies the implicit assumption that all searchers are identical with respect to their wage earning capacity and hence search over the same range of wages. More realistically, however, workers are heterogenious and have different marginal products. Hence, some are earning wages and searching for wages in the area of the distribution below the minimum wage and some in the area above, and the imposition of the minimum wage affects these groups differently, causing spillover effects across labor sub-markets. These aspects of the real world labor market are not captured by our design.

Hypothesis 4: The Robustness of Search Strategy. As reported previously, risk neutral searchers who are tricked into thinking that they are searching from a rectangular distribution but are actually searching from a right triangular distribution search an average of 8.8 times while searchers who are correctly informed that they are searching from a right triangular distribution search on the average only 3.1 times. This huge difference is clear support for Gastwirth's theoretical predictions. A more important question, perhaps, is whether this difference in the mean search duration translates itself into a real difference in the searcher's payoffs. Investigating this question, we found that searchers who are informed that they are searching from a right triangular distribution received an average payoff of $1.008, while those who are misinformed and think they

are searching from a rectangular distribution receive an average payoff of $.903. These differences are not significantly different at the 95% level of significance. Still, an almost 10% difference in payoffs did exist and may indicate that a substantial investment in information dissemination may be justified on a cost-benefit basis if it is likely that searchers are substantially misinformed about the characteristics of the wage distribution from which they search. These results are summarized in table 3.

TABLE 3

Tests of H^1 (Robustness of the Optimal Search Rule)

Group Tested	Mean Payoff	Mean Search Duration
Informed Group (Group III, Trial 6)	$1.008	3.08
Misinformed Group (Group I, Trial 6)	.903	8.80
Differences	.105 (.77)	5.73 (3.47)*

Note: Numbers in parenthesis are the *t* statistics.

*Significant at the 99% level.

Hypothesis 5: Variance of Payoffs of Various Search Strategies. In testing hypothesis 5, we proceed with the implicit assumption that each of our searchers uses a consistent, albeit different search strategy. According to Telser (1973), we might expect their payoffs to differ little from one another. This hypothesis was tested for both the risk averse and risk neutral groups, both within each search trial and over all trial periods. The results are reported in tables 4 and 5.

As can be seen in tables 4 and 5, the variability of payoffs within each trial, for both the risk neutral and risk averse groups, is quite small. As a percentage of the mean, the standard deviation of the payoffs in each trial ranges from a low of 9% in group I-trial 2 to a high of 47% in group I-trial 6, the trial in which we trick our subjects. The overall average percentage of the mean for the standard deviation is about 23%. When we compare the variability of the payoffs in each trial across groups we find that the variance of payoffs in group I (risk neutral) is signifcantly higher than the variance of the payoffs in group II (risk averse) on trials 4, 5, 6, 7, and 11. In other words, different attitudes toward risk do seem to account for some variability in the payoffs of searchers under certain conditions.

TABLE 4

Hypothesis H^5: Profitability of various search strategies +

Group/Trial:	1	2	3	4	5	6	7	8	9	10	11	12	Sum
Risk Neutral (Group I)	.053	.011	.097	.098	.127	.182	NR	NR	NR	.092	.192	.043	1.13
Risk Averse (Group II)	.057	.017	.053	.038	.030	.076	NR	.059	.079	.037	—	—	1.652
Ratio of Group I & II	1.07	1.54	1.80	2.57*	4.2**	2.3*	2.7*	1.01	2.4*	1.1			1.53

*Significant at the 95% level.
**Significant at the 99% level.
NR = not reported

+ The entries in this table are the standard deviations of the profits achieved by the searchers in each of the twelve trial periods.

TABLE 5

Means and Standard Deviations of Payoffs

Trial	Mean	Standard Deviation	Standard Deviation / Mean
Group I:			
1	1.39	.231	.166
2	1.134	.104	.091
3	1.541	.311	.201
4	1.262	.314	.248
5	1.217	.357	.293
6	0.903	.427	.472
7	1.049	.407	.387
10	1.411	.303	.214
11	1.108	.438	.395
12	1.058	.207	.195
Group II:			
1	1.030	.239	.232
2	0.854	.130	.152
3	1.221	.230	.188
4	0.941	.194	.206
5	1.173	.174	.148
6	0.897	.275	.306
7	0.988	.305	.308
8	1.029	.242	.235
9	1.032	.280	.271
10	0.799	.193	.241

This finding is also consistent with the behavior in response to risk aversion that we reported previously. We found that risk averse searchers tend to exaggerate their level of risk aversion and set excessively low reservation wages.[5] Such excesses tend to bunch the reservation wages of the searchers

5. See Hypothesis 1 in our earlier paper.

and can lead to lower variability in the payoffs of the searchers as was discussed above.

Hypothesis 6: Effects of Information States on Payoff Variances. Here we compare the variances of two groups of searchers whose information states vary in that one group is fully informed about the distribution of wages from which they search, while the other is not. These results are reported in table 6. Specifically we compare the behavior of those who are searching from a symmetric triangular distribution in the Basic Search Paradigm and know it with those who are searching from a symmetric triangular distribution and know only that they are searching from one of four possible distributions chosen at random. In addition we compare the behavior of two groups who search from right triangular distributions, but where only one of the groups know the distribution, while the other only know they are searching from one of four possible wage distributions.

TABLE 6

Hypothesis H^6: Payoffs and Information States

Groups Compared	Comparison	Mean of Payoffs	Variance of Payoffs	Difference of Mean	Difference of Variance
Group I, Trial 1 vs. Group III, Trial 1	Informed vs. Uninformed Triangular Distribution	1.329 1.212	.053 .075	0.117 (1.35)	F = (1.42)
Group III, Trial 2 vs. Group III, Trial 6	Informed vs. Uninformed Right Triangular Distribution	1.327 1.008	.117 .121	.319 (2.78)*	F = (1.08)
Group I, Trial 3 vs. Group III, Trial 3	Informed vs. Uninformed Rectangular Distribution	1.541 .834	.097 .128	.707 (6.51)*	F = (1.319)
Group I, Trial 12 vs. Group III, Trial 8	Informed vs. Uninformed Fixed Sequence	1.058 .954	.043 .046	.104 (1.52)	F = (1.06)

Note: Numbers in parentheses are t statistics.
*Significant at the 99% level.

As the results show, if our searchers are indeed searching with different search strategies, the variance of their payoffs are unaffected by the information conditions under which they are placed. This finding can be seen from the fact that the difference of the means of the payoffs vary only insignificantly across information states. Thus, if our searchers use different search strategies, these strategies do not, within any group, make their payoffs vary to any significant extent, even when information conditions vary. This limited set of observations does present some experimental support of Tesler's (1973) simulation results.

CONCLUSIONS

The results of our experiments indicate that if searchers in the real world behave in a manner that is at all consistent with the behavior we have observed, there may exist a wide scope of policy actions available to the government which will allow it to affect the operation and efficiency of labor markets. In addition, it may be expected that many of our present policies (e.g., unemployment insurance, minimum wage legislation, etc.) do have substantial effects on the behavior of workers seeking employment and that these effects, are, to a degree, consistent with the type of behavior that is predicted by the theory of optimal economic search. As was seen throughout our results, the misspecification of information can lead to prolonged periods of search unemployment and greatly increase what might be considered the natural rate of unemployment. Also, this prolonged period of search unemployment does not seem, at least on the basis of our results, to be productive in the sense of leading to a better net payoff for the searchers.

Finally, both this paper and our earlier one present evidence of laboratory behavior that is strikingly consistent with the type of behavior we expect to observe from economic agents who search for wages as if they are using an optimal sequential reservation wage strategy. If these results could be reproduced elsewhere, they may furnish the government policy maker with a good theoretical basis upon which to construct a rational labor market policy, and this may be one of the rare situations in which theoretically derived economic results could be tested in the laboratory before being applied to the real world.

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