Laboratory Tests of Job Search Models

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This essay is concerned with laboratory tests of job search models. Formal models of job search specify certain common elements, i.e. the length of the search horizon, the searcher's discounting rate of interest, the net costs (subsidies) to search in each period of the search horizon, and the searcher's knowledge about the wage offer distribution he or she faces. Because these factors are difficult, if not impossible, to observe in the naturally-occurring economy, controlled laboratory tests of the search model offer the only practical means for formally testing search models.

A basic job search model of interest to economists specifies a finite search horizon. Searchers know the (discrete) wage offer distribution and must accept or decline an offer when it is received. The search model has sharp predictions for a utility maximizing, risk neutral agent. In this case the agent seeks to maximize the expected present value of the income from search. This can be accomplished by choosing an appropriate (minimally acceptable) reservation wage each period. The optimal reservation wage in any given period will equate (or, for discrete wage rates, appropriately order) the incremental benefits of searching an additional period with the incremental costs. Conditional on the draws, the model can predict precisely when an optimizing risk neutral searcher should terminate his or her search. By contrast the model does not have as sharp predictions for an individual with weakly risk averse (i.e., "concave") utility. Such an agent seeks to maximize the expected present value of his or her utility. In doing so the agent will select optimal reservation wages that are either less than or never greater than those that would be selected by an optimizing risk neutral agent. The implication of risk aversion is that the duration of search would on average be no longer than that of an optimizing, risk neutral agent.

1. Basic Search Experiments

Cox and Oaxaca (1989) reports on a set of experiments with the basic search model. In these experiments there is a baseline design and several alternative treatments: Interest, Subsidy, Risk, Cost, Probability, and Horizon. The baseline consists of a 20 period search horizon in which the probability of an offer being generated is 0.5 each period. Conditional upon receiving an offer, the searcher faces a discrete uniform distribution defined over integer values 1 through 10. In the baseline design the induced discounting rate of interest is 0 and subsidies and costs are 0. In the Interest treatment the induced rate of interest is 10%. The Subsidy treatment offers a subsidy of 10 points for each period searched. The Risk treatment consists of replacing the baseline conditional wage offer distribution with a discrete uniform distribution defined over integer values 4 through 7. This treatment reduces the riskiness (dispersion) of wage offers while holding constant the expected wage offer. In the Cost treatment subjects were charged 10 points for each period they searched. In the Probability treatment the probability of an offer being generated was reduced to 0.25 each period. The Horizon treatment consisted of halving the search horizon from 20 periods to 10 periods.

Figure 1 reports the test results for the risk neutral (linear) model and for the risk averse (concave) model. The experimental results were quite consistent with the predictions of the risk neutral model and were highly consistent with the risk averse model. 77% of the experimental searches terminated when predicted by the risk neutral model, conditional on the draws received, while 94% of the experimental searches terminated in periods consistent with the predictions of the risk averse model. Another indication of the strength of the test outcomes for search duration is the *p* value scores for paired differences between subject search durations and predicted durations for each subject conditional on their offers received. Out of 10 experimental treatments or baseline experiments, the *p* values exceeded 0.1 a total of 4 times for the risk neutral model and a total of 9 times for the risk averse model.

To examine treatment effects, a difference-in-difference comparison was made between each treatment and each baseline. The results of these difference-in-difference tests are presented in Figure 2. Actual differences in each subject's search duration between a treatment and a baseline trial were compared to the expected difference predicted by theory, conditional on the draws. There were 12 comparisons (6 treatments and 2 baselines). Out of the 12 comparisons, 9 exhibited p values in excess of 0.1. In addition to tests based on mean durations of search, there were full distribution Kolmogorov-Smirnov tests. Out of 10 experimental treatments or baseline experiments, the risk neutral model could be rejected at the 5% level of significance only once and the risk averse model could never be rejected.

2. Precommitment/No Precommitment Experiments

The search duration tests presented in Cox and Oaxaca (1989) pertaining to the basic search model are indirect in as much as they are based on comparisons between actual stopping points and theoretically-predicted stopping points. A characteristic of the basic search model, however, is the existence of a reservation wage path. In other words the integer dynamic programming solution to the search problem specifies a minimally acceptable wage offer each period. In any given period all offers below the reservation wage will be rejected and all others accepted. A direct test of the search model would compare actual reservation wages with the theoretically predicted, optimal reservation wages. In the naturally-occurring economy actual reservation wages used by searching workers are extremely difficult, if not outright impossible, to observe. In the laboratory it is possible to induce observable minimum acceptable wages that correspond to the theoretical notion of reservation wages.

Search experiments in which observable reservation wages were induced in the laboratory are reported in Cox and Oaxaca (1992a, 1992b). In some of these experiments subjects were required to precommit to a minimally acceptable offer in each period in advance of a draw. Any offer generated that was less than the precommitment wage was not available. All other offers resulted in search being terminated in that trial and the associated earnings being added to the subject's cumulative earnings during the experiment. Although such induced precommitment wages correspond to the theoretical notion of a binding reservation wage, there is always the possibility that subjects may precommitment to wages different than those they would implicitly use in the absence of the requirement to precommit in each period. This phenomenon stems from the possible existence of framing effects. Even though the decision problem is formally the same with or without precommitment, it is possible that the problem could be perceived as different depending on the presence or absence of the precommitment requirement. To the extent that this occurs one cannot accept the induced reservation wages at face value.

The scientific question raised by framing effects in this context is whether or not precommitment is itself a treatment. To answer this question the authors ran parallel precommitment and no precommitment treatments for the same group of subjects so that each subject would serve as his or her own control. The basic treatments consisted of the Baseline, Subsidy, and Probability treatments reported in Cox and Oaxaca (1989). The results reported in Cox and Oaxaca (1992b) suggest that initially subjects behaved as if the precommitment treatment was a riskier proposition. That is to say, the precommitment reservation wages were causing search to be terminated earlier than in parallel treatments without precommitment, after controlling for the offers received. After a few trials subjects returned to the baseline behavior observed in the parallel no precommitment experiments. Thus, the precommitment effects wore off as the subjects acclimated themselves to the precommitment design.

The direct tests themselves are reported in Cox and Oaxaca (1992a). In order to better gauge how well the risk neutral model is actually doing, a naive decision rule is used as a comparison case. The naive decision rule used specifies a reservation wage equal to the lowest integer value above the mean of the wage offer distribution except in the last period of the search horizon. In the last period the reservation wage would logically be 0.

Figure 3 reports the test results based on search terminations. When one combines the data from the precommitment and parallel no-precommitment treatments, it turns out that 2/3 of the subjects stopped at the theoretically-predicted risk neutral stopping periods 75% or more of the time. The naive model performed almost as well as the risk neutral model. In comparison, slightly in excess of 2/3 of the subjects stopped in periods consistent with the risk averse model 94% or more of the time. Nearly half of the subjects stopped at periods consistent with the risk averse model 100% of the time.

Figure 4 reports the test results based on mean reservation wage paths. Using only the data from the precommitment experimental trials, one can test whether the mean reservation wage path observed for each treatment is significantly different from the theoretically-predicted path for a risk neutral agent. On the basis of this direct test, Cox and Oaxaca (1992a) were able to reject both the risk neutral model and the naive model. At the same time the risk averse model survived the direct tests quite handily. The *p* values ranged from 0.43 to nearly 1.00.

3. Recall Experiments

In the basic search model, searchers do not have the option of recalling previously declined wage offers. The availability of a recall option makes search an inherently less risky enterprise. At the same time the presence of a recall option complicates the search environment. In each period of the search horizon, the optimizing searcher must consider the values of all previous offers and the probabilities of their continued availability. Laboratory experiments with recall are reported in Cox and Oaxaca (1996). These experiments examine both perfect recall (all previous offers are available) and stochastic recall (the availability of a past offer declines geometrically with the number of periods lapsed since the offer was generated). The experimental treatment sequence was as follows: Baseline (no recall), Perfect Recall, Baseline (no recall), Stochastic Recall.

Both parametric (matched pairs) and nonparametric (Fisher sign) tests of the linear and concave search models are reported in Cox and Oaxaca (1996). Figure 5 presents the results of tests of the risk neutral model. With the exception of the first baseline treatment, the risk neutral (linear) model is rejected by both sets of tests. The linear model for the first baseline is not rejected by the matched pairs test, although it is rejected at the 7.6% percent level by the Fisher sign test.

Figure 6 presents the results of tests of the risk averse model. As in the previous experiments, the risk averse (concave) model cannot be rejected for any treatment at conventional levels of significance. The lowest *p* value generated for the concave model is 0.854.

Figure 7 reports tests of treatment effects compared to the theoretical predictions and their implications for the risk neutral and risk averse models. As a first approximation one might conclude that risk aversion offers a satisfactory explanation of search behavior. Search duration is always less than the predictions of the risk neutral model, conditional on the wage offers that were generated in the experiment. Conditional on the actual draws, theory predicts that search duration will rise under perfect recall relative to either baseline treatment. Although this is in fact observed, the increase in search duration under perfect recall is markedly less than the theoretical predictions.

Subjects are reacting to an inherently less risky search opportunity by behaving as if search were more risky. Thus the theory is not tracking how subjects respond to the introduction of perfect recall. Treatment effects are tested with the difference-in-difference methodology by comparing observed differences in search duration between all pairs of treatments with theoretically predicted differences in search duration. The only rejections of theoretical predictions occur when comparing perfect recall with the baseline treatments.

4. Extensions of the Standard Search Model

Experimental research with job search theory has been extended, beyond the questions discussed in this essay, to include search intensity (Harrison and Morgan, 1990) and search from unknown distributions (Cox and Oaxaca, 2000).

Acknowledgement

Charles Kiser provided valuable assistance by preparing the figures.

References

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Figure Legends

Figure 1. This figure reports the results of tests of the risk neutral (linear) model and the risk averse (concave) model based on mean search durations for treatments under the basic search model. The risk neutral model offers precise predictions for search terminations, conditional on the draws. Hence, the statistical tests are two-tailed. On the other hand, the risk averse model predicts only that search will terminate at or before the period predicted by the risk neutral model. The red bars indicate the *p* values associated with tests of the risk averse model and the blue bars indicate the *p* values associated with tests of the risk neutral model. Of the ten treatments, the risk averse model would be rejected at conventional levels in only one case (the horizon treatment). The risk neutral model would be rejected at conventional levels in six of the ten treatments.

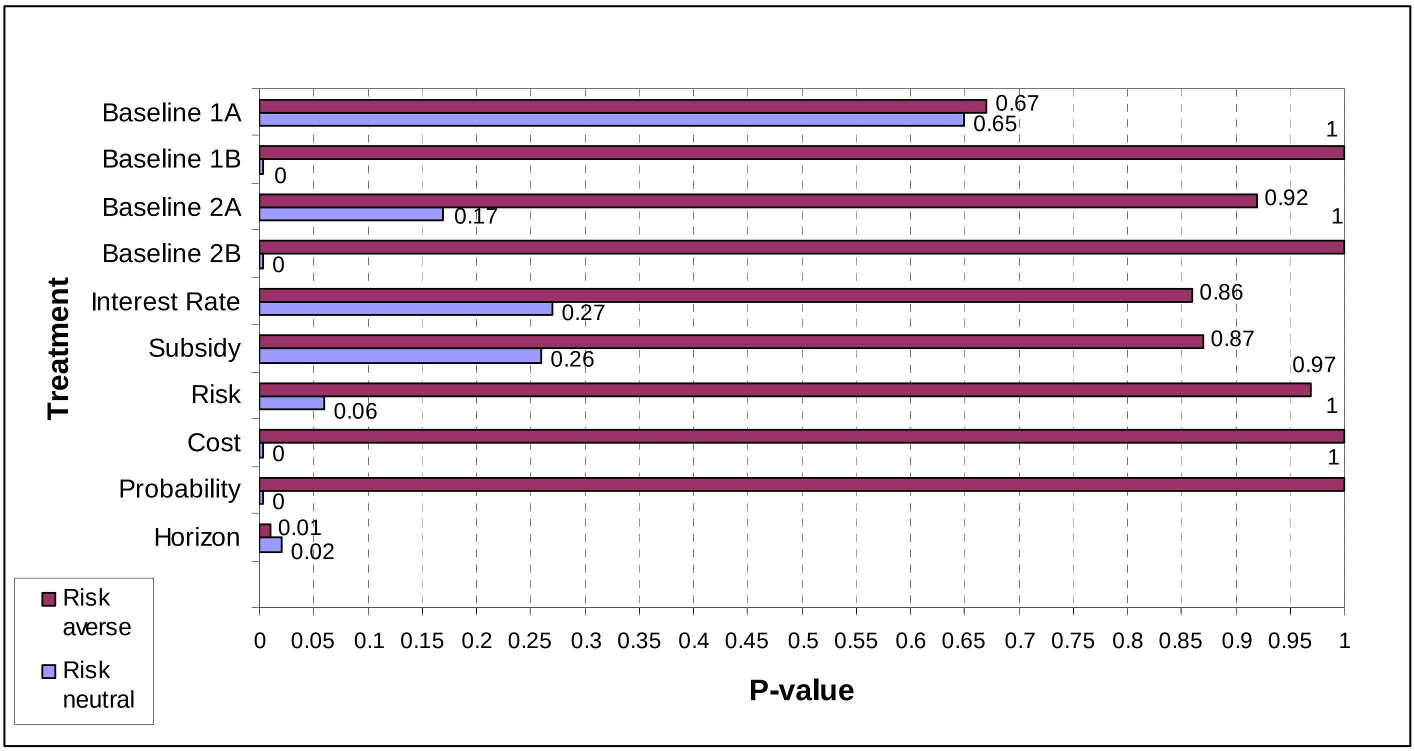

Figure 2. This figure reports the results of difference-in-difference tests in which observed differences in search terminations between each pair of treatments are compared against theoretically predicted differences, conditional on the draws. These tests are designed to capture treatment effects relative to the baseline treatments. The blue bars represent *p* values from matched pairs tests. There were two sets of baseline treatments (A and B) corresponding to different sets of subjects. The A baseline comparisons are not labeled but are reported above each corresponding B baseline comparison. The results show that treatment effects predicted by theory would be rejected in only three of the twelve comparisons.

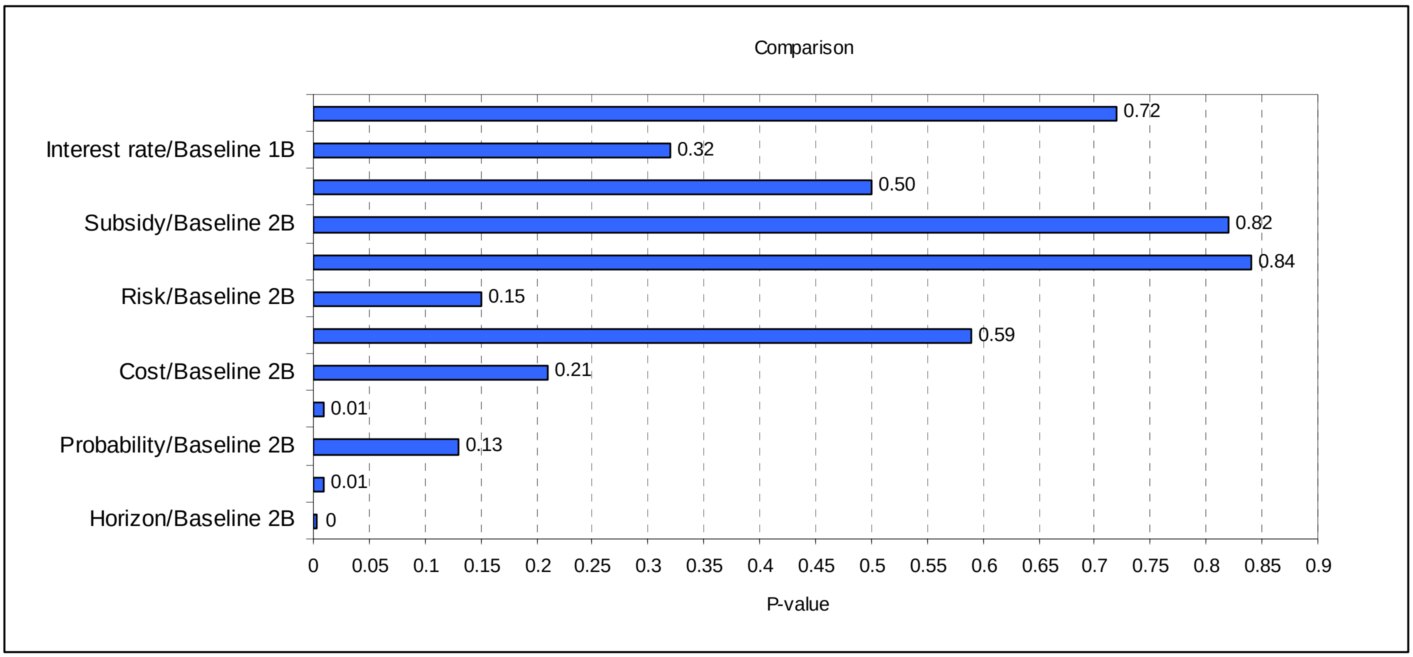

Figure 3. This figure reports the distribution of theoretically-correct search terminations across thirty subjects in the precommitment/no-precommitment experiments. With precommittment, subjects are required to commit to a minimally acceptable offer in advance of each draw. The red bars correspond to the number of subjects whose search terminations were consistent with the concave model at a given percentage, while the yellow bars correspond to the number of subjects whose search terminations were consistent with the linear model. The percentages were calculated over the combined precommitment and no-precommitment treatments. Thus 2/3rds (20 out of 30) of the subjects had search durations that were consistent with risk neutrality at least 75% of the time. The figure also shows that slightly more than 2/3rds (21 out of 30) of the subjects had search durations that were consistent with risk aversion at least 94% of the time.

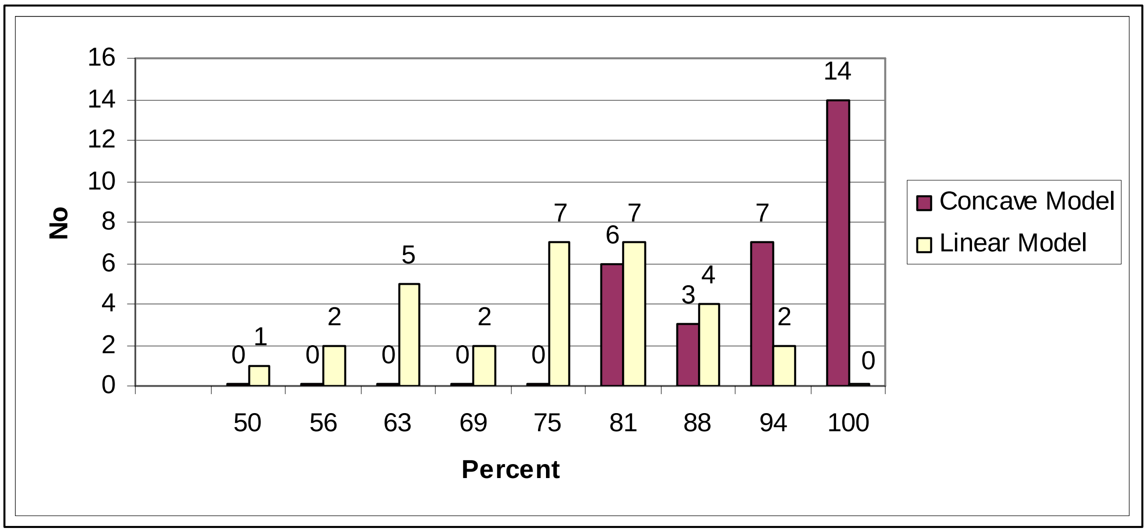

Figure 4. This figure reports the results of direct tests of the observed mean reservation wage paths for the precommitment treatments. In addition to the risk neutral (linear) model and the risk averse (concave) model, a naive model is also tested. The naive model predicts a search termination at any offer above the mean of the distribution except in the last period of the horizon in which case any offer would be accepted. The red bar corresponds to the *p* values associated with the naive model and the blue bar corresponds to the *p* values associated with the risk averse model. The risk neutral model exhibited a *p* value of 0 for every treatment and therefore can be rejected in every case. The naive model is also rejected for every treatment but the risk averse model is never rejected.

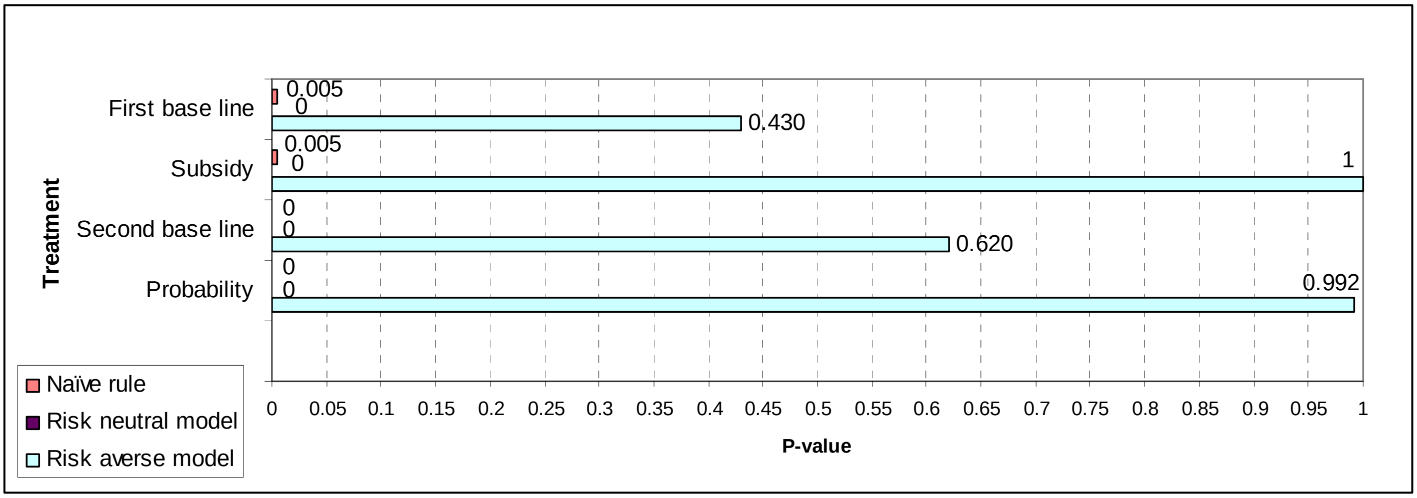

Figure 5. This figure presents the results of nonparametric (Fisher sign) and parametric (means matched pairs) tests of the risk neutral model in a recall search environment. In the perfect recall treatment every previously generated wage offer is available for recall in subsequent search periods. With stochastic recall, previously generated wage offers are available with probabilities that decline geometrically with the number of periods elapsed since the offers were originally generated. The purple bars report the *p* values for the sign test and the blue bars report the *p* values for the means tests. The risk neutral model can be rejected in all but one instance (the means test for the first baseline treatment.

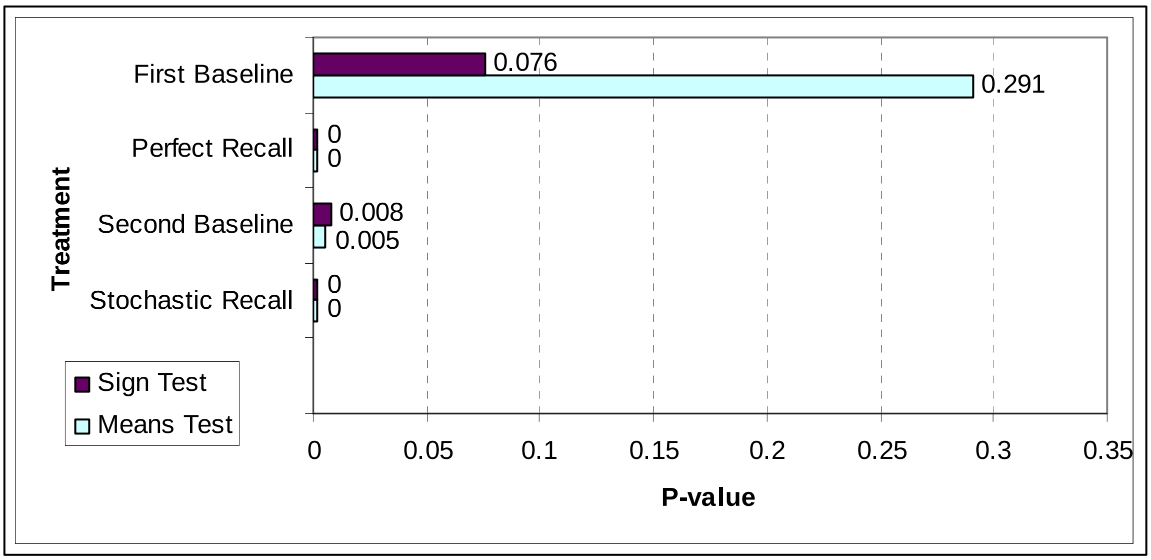

Figure 6. This figure presents the results of nonparametric (Fisher sign) and parametric (means matched pairs) tests of the risk averse model in a recall search environment. In the perfect recall treatment every previously generated wage offer is available for recall in subsequent search periods. With stochastic recall, previously generated wage offers are available with probabilities that decline geometrically with the number of periods elapsed since the offers were originally generated. The purple bars report the *p* values for the sign test and the blue bars report the *p* values for the means tests. The risk averse model is never rejected as the lowest *p* value is 0.854.

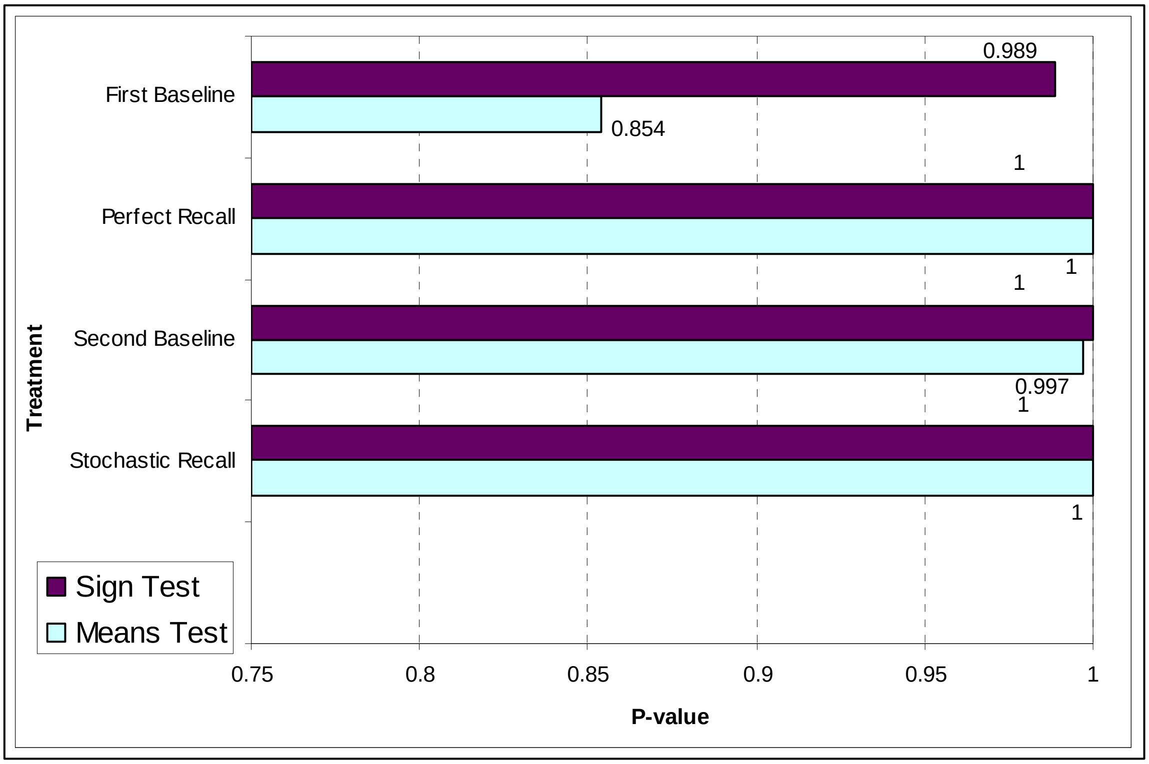

Figure 7. This figure reports the results of difference-in-difference tests in which observed differences in search terminations between each pair of treatments are compared against theoretically predicted differences, conditional on the draws. These tests are designed to capture treatment effects relative to the baseline treatments. The blue bars represent *p* values from matched pairs (means) tests and the red bars represent *p* values from the Fisher sign test. Theoretical predictions can be rejected for the perfect recall/baseline comparisons. The theory does not adequately predict subject behavior with the introduction of perfect recall.