FINITE HORIZON JOB SEARCH, NULL OFFERS

AND THE DURATION OF SEARCH UNEMPLOYMENT.

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This paper is circulated for discussion purposes only and its contents should be considered preliminary.

Finite Horizon Job Search, Null Offers and the Duration of Search Unemployment.

1. Introduction

The predictions of job-search theory for an analysis of unemployment have long been of interest (e.g. see Lippman and Mc Call (1976 b), Barron (1975) and Feinberg (1977)). In particular an important question is with regard to the duration of search unemployment and its determinants. Unfortunately robust results in this area are few. The reason for this being the complexity of the solutions to optimal job search problems. In many cases (see Chalkley (1982) for summary) the optimal search strategy involves setting a reservation wage. If an offer in excess of the reservation wage is obtained it is optimal to accept the offer, otherwise continued search is preferable. Where the reservation property[1] holds it is relatively simple to relate the expected duration of search unemployment to the (set of) reservation wage(s). However the reservation wage(s) themselves can seldom be expressed analytically. In the absence of analytic expressions for the reservation wages an examination of the effect of changes in parameters of the problem on (for example) the duration of unemployment would seem to require numerical analysis.

In this paper a specific form of job search model is examined. The predictions of this model, with regard to the duration of search unemployment are of particular interest, because it allows in a simple way for the possibility of demand constraint in job search.

In Section 2, the Null-Offer job search model will be outlined. The optimal search strategy is defined and the implications of this strategy for the expected duration of unemployment studied.

In section 3 a restriction is placed upon the model so that strong predictions can be made regarding the response of the duration of unemployment to changes in a parameter of the model. The approach here follows directly Barron (1975) and Feinberg (1977).

Section 4 presents the results of some numerical analysis of the Null Offer model, where the restriction of section 3 is relaxed. It is shown that the restriction of section 3 affects the results.

Section 5 presents a summary and some suggestions for future work.

2. The Null Offer Job Search Model

The basic job search model as outlined in Lippman and Mc Call (1976 a) is by now very well known. An individual initially unemployed is assumed to search for a job. In each period (s)he can obtain exactly one job offer at cost 'c'. Jobs are assumed to vary only with regard to the (discounted lifetime) wage they offer. The individual maximises expected (discounted lifetime) wage net of search costs[2]. If there is no limit to the number of offers the individual is able to obtain the optimal strategy involves setting a single reservation wage y* which is the solution to [3];

$$(2.1) \qquad \int_{y^*}^{\infty} (w - y^*)\, f(w)dw - c = 0$$

where f(w) is the probability density function of (discounted lifetime) wages,

and c is the cost of search.

If there is a limit to the number of offers the individual can obtain then the optimal strategy depends on whether past offers remain available. Where past offers are available (the recall case) there is (excepting the last period of search where <u>any</u> offer is acceptable) a single reservation wage once again the solution to (2.1) (see Lippman and Mc Call (1976 a)). Where past offers are unavailable (the no-recall case) there are n reservation wages <u>one</u> for each period of search, furthermore the reservation wages fall through time.

Lippman and Mc Call consider a variant of the above model where there is only a probability 'q' that an offer will be forthcoming in any period. Henceforth this will be referred to us as the Null Offer model since there is a probability (1-q) that a zero or null offer is forthcoming. q can be seen as a simple proxy for labour market conditions. If wages (or in this case a distribution of wages) were to adjust so as to 'clear' the market we might expect no rationing of offers. In the absence of such market clearing, rationing becomes possible. A high degree of rationing might be represented by low q.

The optimal search strategy is most easily seen by viewing job search as a multi-stage dynamic programming problem. If $V_n(\bar{w})$ denotes the maximum expected (discounted lifetime) wage when n further searches are possible, $\bar{w}$ is the best available offer and future search is to be conducted optimally, then

$$(2.2)\quad V_n(\bar{w}) = \max\{\bar{w}, -c + q\,E\left[V_{n-1}(w/\bar{w})\right] + (1-q)\,V_{n-1}(0/\bar{w})\}$$

since at each stage the individual has the choice of 2 options, either to stop search (which has value $\bar{w}$) or to continue (which has expected value $qE\left[V_{n-1}(w/\bar{w})\right]+(1-q)V_{n-1}(o/\bar{w}) - c$).

A reservation wage exists in any period if a value of $\bar{w}$ (say y_n^*) solves.

$$(2.3)\quad \bar{w} + c - q\,E\left[V_{n-1}(w/\bar{w})\right] - (1-q)\,V_{n-1}(0/\bar{w}) = 0$$

and for $\bar{w}$ greater than this value

$$(2.3a)\quad \bar{w} > -c + q\,E\left[V_{n-1}(w/\bar{w})\right] - (1-q)\,V_{n-1}(0/\bar{w}).$$

In the case of recall[4] it is possible to show that (except in the case of the last period) there is a single reservation wage[5] which is the solution to

$$(2.4)\quad c = q\int_{y^*}^{\infty} (w - y^*)\, f(w)\, dw.$$

In the absence of recall $E\left[V_{n-1}(\quad)\right]$ does not depend on $\bar{w}$ (simply because past offers cannot be used). In this case there will be n reservation wages that can only be determined recursively (and not expressed analytically). Notice however in this case that (2.3) reduces to

(2.5) $\bar{w} + c - k_n = 0$ where k_n is a constant (independent of $\bar{w}$ but varying with q)

and therefore numerical evaluation of the reservation wages is relatively straightforward.

It has been noted by Barron (1975) and Feinberg (1977) that the expected duration of unemployment can be easily derived when there is a single reservation wage. Strictly speaking this is only the case when N (the search horizon) is infinite[6].

The probability 'p' that in any given period an offer will be accepted (and therefore search terminated) is simply

(2.6) $p = (1 - F(y^*))$ where $F(w)$ is

the density function of wage offers.

The probability of receiving an offer is simply q and therefore the probability of terminating search in any period is p.q. The probability therefore that unemployment duration is exactly k periods is

(2.7) $(1 - p.q)^{k - 1} . p.q.$

Where N is infinite the duration of unemployment is a geometric random variable with parameter p.q the expectation of which is $^1/p.q$ or

(2.7a) $E\left[D\right] = q\,(1 - F(y^*))^{-1}$

The expected duration of search unemployment when the search horizon is finite has never been derived in the literature. From the above discussion it is apparent that there are two cases to be considered recall and no-recall.

We assume throughout the following that an offer accepted when n further searches are possible is started in period $n - 1$. The maximum duration of search unemployment is thus $N + 1$ periods (where N is the search horizon).

In the case of recall there is a single reservation wage for all periods of search except the last (where the reservation wage is zero - and <u>any</u> offer is acceptable). The probability that an offer is accepted is therefore simply $(1 - F(y^*))$ for periods $N, N - 1 \ldots \ldots \ldots 1$ and 1 for period 0. The probability of receiving an offer is by definition q in all periods. The probability that an individual is unemployed for exactly k periods is therefore simply

$$(2.8)\quad q\ (1 - F(y^*)) \times ((1 - q) + q\ F(y^*))^{k-1}$$

The expected duration of unemployment is thus:

$$(2.9)\quad E\left[D\right] = q\ (1 - F(y^*)) + \sum_{i=2}^{N} iq\ (1-F(y^*))\ ((1 - q) + q\ F(y^*))^{i-1}$$

$$+ (N + 1)\ q((1 - q) + qF(y^*))^{N}$$

The last term takes account of the fact that in the last search period the reservation wage is zero.

In the case of no-recall the issue is further complicated by the fact that there is a different reservation wage in each period. The reasoning however is the same as before and an expression for the expected duration of search unemployment can be derived as

$$(2.10)\quad E\left[D\right] = q\ (1 - F(y^*_N)) + \sum_{i=2}^{N+1} iq\ (1 - F(y^*)\ \ (N-i+1).\prod_{j=N-(i-2)}^{N} ((1-q)+qF(y^*_j))$$

From (2.4) and (2.5) it is clear that y^* and y_n^* are in fact functions of q. It is therefore not obvious how $E[D]$ varies with q. As Barron (1975) notes there are 2 effects to be considered.

Firstly if q decreases we would expect $E[D]$ to increase since the probability of getting a Null offer in each period increases.

Secondly, as q decreases y^* or y_n^* decrease - thus increasing the probability that an offer if obtained will be accepted, cet par $E[D]$ decreases.

In the next section we examine the relationship between $E[D]$ and q when the search horizon is infinite. In particular we are interested in knowing whether $\frac{dE(D)}{dq}$ can be unambiguously signed. In section 4 some numerical results are reported for the finite horizon case (as summarised by (2.9) and (2.10) above).

3. The Expected Duration of Unemployment given an infinite search horizon.

The only case examined in the literature is that expressed in (2.7a) where there is an infinite search horizon. Barron (1975) noted a negative relationship between vacancies (which can be seen as a proxy for q) and the average duration of unemployment. Feinberg (1977) shows that this relationship follows from job search theory. Feinberg (1977) and Barron (1975) both consider an aggregate model. Since the assumptions necessary to aggregate over individuals are restrictive and given the possibility of testing a search model on individual survey (rather than aggregate time series) data, it is useful to re-examine their approach within the individual framework.

We are concerned with the sign of $\frac{dE[D]}{dq}$. From (2.7a) and remembering that $y^* = g(c, F(w), q)$

$$(3.1) \quad \frac{dE[D]}{dq} = \left(-\frac{1}{qp^2}\right)\frac{\partial p}{\partial q} - \frac{1}{q^2 p}$$

If $\frac{dE[D]}{dq}$ is to be negative (as asserted on the basis of empirical data by Barron (1975))we require

$$(3.1\ a) \quad \left(\frac{-1}{qp^2}\right)\frac{\partial p}{\partial q} - \frac{1}{q^2 p} < 0$$

or alternatively that

$$(3.2\ b) \quad \frac{\partial p}{\partial q} \cdot \frac{q}{p} > -1.$$

Intuitively the acceptance probability p is required to be inelastic with respect to q (the first of the two effects on p.10 would then dominate).

Using (2.4a) $\frac{\partial p}{\partial q}$ is (see appendix A for derivation),

$$(3.2) \quad \frac{\partial p}{\partial q} = \frac{-f(y^*)}{(1-F(y^*))} \quad \frac{1}{q} \int_{y^*}^{\infty} (w - y^*) \, f(w) dw$$

Substituting (3.2) into (3.1b) gives

$$(3.3) \quad - \frac{1}{(1 - F(y^*))} \quad \frac{f(y^*)}{(1 -(F \, y^*))} \int_{y^*}^{\infty} (w-y^*) \, f \, (w) dw \; > -1$$

Whether this inequality holds depends on the parameters and form of the offer distribution (f(w))

In the case of a normal distribution (which alone will be considered here) (3.3) can be re-arranged to give (see Appendix A).

$$(3.4) \quad - \frac{1}{(1-F(y^*))} \; . \; f(y^*) \left[\frac{\sigma^2}{(1-F(y^*))} \; f(y^*) \; + \; \mu - y^* \right] > -1$$

This inequality is satisfied for any specification of μ, σ and y^* such that $(1 - F(y^*)) > 0.005$ and hence in general $\frac{dE[D]}{dq} < 0$.

The above result is for the case of a single reservation wage and is thus only valid for the case of an infinite search horizon. However to assume individuals are able to search indefinitely ignores the fact that wealth may be limited. For this reason in the next section we examine the relationship $\frac{dE(D)}{dq}$ when the search horizon is finite. In the case of perfect recall there is a single reservation wage (excepting the final period) which can be expressed analytically (see (2.4)). The expression for expected duration is however considerably more complicated than in the infinite horizon case so that numerical evaluation enables us to easily produce results. In the case of no-recall the reservation wages are defined only recursively and in this case numerical evaluation is necessary to produce results.

4. The Expected Duration of Unemployment and Finite search horizons

4.1 The Recall Case

In this case the appropriate expression for expected duration is (2.9). By inspection it is clear that $dE(D)/dq$ will be a function of N - the search horizon, but the form of this relationship is not clear. The optimal reservation wage y^* can fairly simply be computed for a given $F(w)$, q and c, by choice of N and substitution into (2.9) $E(D)$ can be calculated.

Since the concern here is with the sign of $dE[D]/dq$ it was decided to fix the parameters of the offer distribution $F(w)$. In the following tables the expected duration of unemployment (for different search horizons) are reported, based on a normal; $\mu = 1000$, $\sigma = 100$, lifetime wage offer distribution. Since these results are intended as illustrative, only 3 values of the cost of search are examined.

RECALL - UNEMPLOYMENT DURATIONS.

Table 1. μ = 1000. σ = 100. c = 100.

N \ q	1.0	.75	.50	.25	.05	dE[D] / dq
5	1.23	1.47	1.91	2.22	*	- ve
10	1.23	1.48	2.04	3.37	*	- ve
20	1.23	1.48	2.05	3.94	*	- ve
30	1.23	1.48	2.05	4.0	*	- ve
40	1.23	1.48	2.05	4.0	*	- ve
50	1.23	1.48	2.05	4.0	*	- ve
∞	1.23	1.48	2.05	4.0	*	- ve

Table 2. μ = 1000. σ = 100. c = 10

N \ q	1.0	.75	.50	.25	.05	dE(D) / dq
5	3.81	3.32	2.81	2.10	0.88	+ ve
10	4.81	4.57	4.40	3.99	2.34	+ ve
20	5.29	5.40	5.86	6.48	5.99	- ve/ + ve
30	5.35	5.55	6.25	7.45	9.45	- ve
40	5.36	5.58	6.35	7.82	12.59	- ve
50	5.36	5.59	6.37	7.95	14.92	- ve
∞	5.36	5.59	6.38	8.00	20.47	- ve

Table 3. μ = 1000. σ = 100. c = 1.

q / N	1.o	.75	.50	.25	.05	$\frac{dE(D)}{dq}$
5	5.58	4.30	2.99	1.67	0.52	+ ve
10	9.53	7.52	5.42	3.30	1.32	+ ve
20	15.87	13.09	9.97	6.97	3.66	+ ve
30	20.59	17.64	13.96	10.84	6.70	+ ve
40	24.10	21.34	17.34	14.65	10.16	+ ve
50	26.71	24.32	20.15	18.24	13.82	+ ve
∞	34.3	35.99	37.25	41.27	57.84	- ve

These illustrative results clearly show that in the case of a finite search horizon the sign of $\frac{dE[D]}{dq}$ is ambiguous. (Notice in all cases that the infinite horizon $\frac{dE(D)}{dq}$ is-ve confirming the analytic result of section 3). The sign of $\frac{dE(D)}{dq}$ depends on the search horizon, the shorter is the horizon the more likely <u>cet par</u> is $\frac{dE[D]}{dq}$ positive. There is clearly a critical horizon length N* such that for N>> N* $\frac{dE(D)}{dq}$ is negative and for N<< N* $\frac{dE[D]}{dq}$ is positive. For values near N* $\frac{dE[D]}{dq}$ may change in sign depending on q (see Table 2. N = 20). The greater is the cost of search the smaller <u>cet par</u> is N* (comparing tables 1, 2 and 3).

4.2 The No Recall Case

Here the appropriate expression for E[D] is (2.10). Not only is the sign of $\frac{dE[D]}{dq}$ not clear from inspection but also the reservation wages y_n^* $\forall n$ are only defined recursively by(2.5). It is therefore impossible to analytically put a sign to $\frac{dE[D]}{dq}$.

It is however possible for a given specification of problem to calculate the set of reservation wages and hence by substitution into (2.10) to calculate the expected duration of unemployment.

Here we report for the same specifications as in 4.1 the results of such numerical analysis. The actual calculated reservation wages for c = 100 and c = 10 are included in Appendix B.

Table 4. μ = 1000. σ = 100. c = 100.

UNEMPLOYMENT-DURATIONS

N \ q	1.0	.75	.50	.25	.05	$\frac{dE[D]}{dq}$
5	1.23	1.47	1.80	1.86	*	- ve
10	1.23	1.48	2.03	3.21	*	- ve
20	1.23	1.48	2.05	3.92	*	- ve
30	1.23	1.48	2.05	3.98	*	- ve
40	1.23	1.48	2.05	4.0	*	- ve
50	1.23	1.48	2.05	4.0	*	- ve

Table 5. μ = 1000. σ = 100. c = 10.

NO-RECALL

N \ q	1.0	.75	.50	.25	.05	$\frac{dE[D]}{dq}$
5	3.18	2.88	2.26	1.87	0.66	+ ve
10	4.46	4.42	4.08	3.51	2.04	+ ve
20	5.25	5.52	5.79	5.99	5.66	+ ve/ - ve
30	5.36	5.73	6.28	7.25	9.27	- ve
40	5.38	5.76	6.39	7.75	12.29	- ve
50	5.38	5.78	6.41	7.92	14.63	- ve

Table 6. μ = 1000. σ = 100. c = 1.

q / N	1.0	.75	.50	.25	.05	$\frac{dE[D]}{qd}$
5	3.7	3.23	2.39	1.87	.66	+ ve
10	6.30	5.86	4.93	3.73	2.04	+ ve
20	10.60	10.20	9.37	7.82	5.66	+ ve
30	14.32	13.93	13.26	11.82	9.28	+ ve
40	17.68	17.24	16.70	15.53	12.49	+ ve
50	20.74	20.22	19.75	18.92	15.48	+ ve

The results here are very similar to those of section 4.1. Once again the sign of $\frac{dE[D]}{dq}$ depends on the search horizon and the critical value of the search horizon depends on the cost of search.

The fact that these results are very similar to those for recall is encouraging. The inability to express the set of n reservation wages analytically has led to the no-recall case receiving very little attention, but the assumption that individuals are able to recall all offers made to them is a very strong one. A more general treatment would require an examination of intermediate cases or imperfect recall (see Landsberger and Peled (1977)). The results presented here however suggest that the ability or otherwise to recall offers may not matter, if we are primarily interested in the predictions of search theory for some particular aspects of unemployment.

5. Discussion and Conclusions

This paper has attempted to extend previous work (Barron (1975) and Feinberg (1977)) regarding the predictions of job search theory for a study of the duration of unemployment. A particular form of job search model was investigated that allowed through a probability (1 - q) of null offers for possible quantity constraints in the individual's search environment. This type of null-offer model was first proposed by Barron (1975) and subsequently reviewed by Lippman and Mc-Call (1976a).

A previous result due to Feinberg (1977) suggested that the change in the expected duration of search unemployment with respect to q (the probability of an offer) was theoretically unambiguous in direction. This result has been shown to no longer hold if the possibility of a finite search horizon is allowed for. The analysis conducted here required the derivation of expressions for the expected duration of unemployment given a finite horizon. These expressions have not previously been derived.

The sign of $\frac{dE\ (D)}{dq}$ was examined using numerical analysis : a technique that appears necessary in the case of search (finite horizon) without recall due to an inability to express the set of reservation wages analytically.

The sign of $\frac{dE\ (D)}{dq}$ was found to depend in a systematic fashion on the search horizon. _Cet par_ a shorter search horizon leads to a greater chance that $\frac{dE\ (D)}{dq}$ is + ve (i.e. opposite in sign to Feinberg's (1977) result). The critical length of search horizon depends upon the level of reservation wages and therefore the cost of search. The higher the cost of search _cet par_ the longer the critical horizon length.

The results for recall and no-recall cases were very similar, thus suggesting that the recall assumption may not be critical particularly if one is interested only in general predictions regarding search unemployment. Further numerical analysis would however be required before this conclusion could be extended to other predictions.

Finally some discussion of empirical validation or testing of the above results is required. Barron (1975) took an observed negative correlation between vacancies (a possible proxy for q) and the average duration of unemployment as evidence of the postulated relationship $\frac{dE[D]}{dq}$. Unfortunately such evidence cannot be taken as very conclusive.[7]

The model presented here was based on individual decision making, and empirical work concerning unemployment increasingly concentrates on individual survey data. (See for example Nickell (1979)). It would therefore seem both appropriate and possible to test the above predictions against individual data. One note of caution is however required.

The results presented here were based on comparative statics. We have compared the expected duration of unemployment given one value of q with that given an alternative value. Over the business cycle however we might expect q to be continually varying, in which case we need to take into account how individuals' expectations of q are determined in order to examine optimal search behaviour.

It is apparent that further work is required if the <u>model</u> of search proposed here (rather than just one aspect of that model) is to be empirically tested.

Footnotes

1. The reservation property will be said to hold if in each search period there is a reservation wage, irrespective of whether this reservation wage is the same between periods.

2. And hence is assumed Risk Neutral - see Chalkley (1982) for a discussion of the effect of relaxing this assumption.

3. Numerous derivations of (and proof of the optimality of) the reservation wage are available (see Chalkley (1982) which uses the same notation as here).

4. Recall here refers to perfect recall, in the case of imperfect recall (i.e. a probability of no-recall) there is again a sequence of n reservation wages but the derivation of these is more complicated and is not attempted here (see Landsberger and Peled (1977)).

5. This result follows directly from the derivation given for the basic search model (i.e. no Null Offers) in Lippman and Mc Call (1976a) or Landsberger and Peled (1977) and is therefore not repeated here.

6. In fact Feinberg (1977) (p 1012) claims the result demonstrated in section 3 for the finite horizon case - discussion here shows that this is incorrect.

7. One problem with aggregate time series data is that it includes the effects of all changes in flows into or out of unemployment, whereas we are trying to isolate one particular 'flow' namely that out of unemployment into employment.

Appendix A.

A.1 Derivation of (3.2) NB $y^* = g(c, F(w), q)$

$$p = 1-F(y^*) = \int_{y^*}^{\infty} f(w)\,dw \qquad (A1)$$

$$\partial p/_{\partial q} = \int_{y^*}^{\infty} \frac{df(w)}{dq}\,dw + 0 - \frac{\partial y^*}{\partial q} f(y^*)$$

$$= \frac{-\partial y^*}{\partial q} f(y^*) \qquad (A2)$$

y^* is defined implicitly by (2.4) i.e.

$$q \int_{y^*}^{\infty} (w-y^*) f(w)\,dw - c = 0 \qquad (A3)$$

$$\text{let} \int_{y^*}^{\infty} (w-y^*)\, f(w)\,dw = h(y^*)$$

Differentiating (A3) w.r.t. q yields

$$q \frac{\partial h(y^*)}{\partial q} + h(y^*) = 0 \qquad (A4)$$

$$\frac{\partial h(y^*)}{\partial q} = \frac{\partial h(y^*)}{\partial y^*} \frac{\partial y^*}{\partial q} \qquad (A5)$$

$$(A4) \Rightarrow \frac{-\frac{1}{q}\, h(y^*)}{\frac{\partial h(y^*)}{\partial y^*}} = \partial y^*/_{\partial q} \qquad (A6)$$

$$\frac{\partial\, h(y^*)}{\partial y^*} = \int_{y^*}^{\infty} - f(w)\,dw = -\,(1 - F(y^*)) = -\,p \qquad \text{(A7)}$$

so that $$\frac{\partial y^*}{\partial q} = -\frac{1}{q} \int_{y^*}^{\infty} (w - y^*)\ f\ (w)\ dw \cdot \frac{1}{-p} \qquad \text{(A8)}$$

and hence (A1) becomes

$$\frac{\partial p}{\partial q} = \frac{-\ f(y^*)}{(1 - F(y^*))} \ \frac{1}{q} \int_{y^*}^{\infty} (w - y^*)\ f\ (w)\ dw \qquad \text{(A9)} \quad \text{(3.2)}$$

A2 Derivation of (3.4)

We require for $\frac{dE\,[D]}{dq} < 0$ that $\frac{\partial p}{\partial q} \cdot \frac{q}{p} > -1$

Using (3.2) $$\frac{\partial p}{\partial q}\ \frac{q}{p} = -\ \frac{f(y^*)}{p^2} \int_{y^*}^{\infty} (w - y^*)\ f\,(w)\ dw \qquad \text{(A10)}$$

If $w \sim N\ (\mu\ ,\ \sigma)$

(A10) => $$-\ \frac{1}{p\ \sigma\ \sqrt{2\pi}}\ \exp\left[\frac{-1}{2}\ \frac{(y^* - w)^2}{\sigma}\right] \left[\frac{1}{p\sigma\ \sqrt{2\pi}} \int_{y^*}^{\infty} w\ \exp\left[-\ \frac{1}{2}\ \left(\frac{w-\mu}{\sigma}\right)^2\right] dw\ -\ y^*\right]$$

Letting $z = (w - \mu) / \sigma$ $\quad (dz = {}^{dw}/\sigma \; ; \quad dw = \sigma dz)$

$$\int_{y^*}^{\infty} w \exp\left[{}^{-1}/2\left(\frac{w-\mu}{\sigma}\right)^2\right] dw = \int_{\left(\frac{y^*-\mu}{\sigma}\right)}^{\infty} (z\sigma + \mu)\left[\exp\left({}^{-z^2}/2\right)\right]\sigma dz$$

$$= \sigma^2 \int_{\frac{(y^*-\mu)}{\sigma}}^{\infty} z \exp\left[\frac{-z^2}{2}\right] dz + \mu \int_{\frac{(y^*-\mu)}{\sigma}}^{\infty} \exp\left[\frac{-z^2}{2}\right] dz$$

$$= \sigma^2 \left[-\exp\left[\frac{-z^2}{2}\right]\right]_{\frac{(y^*-\mu)}{\sigma}}^{\infty} + \mu \int_{y^*}^{\infty} \exp\left[\frac{-1}{2}\left(\frac{w-\mu}{\sigma}\right)^2\right] dw$$

$$= \sigma^2 \exp\left[-\frac{1}{2}\left(\frac{y^*-\mu}{\sigma}\right)^2\right] + \mu p\sigma \sqrt{2\pi} \qquad \text{(A11)}$$

Substituting (A11) into (A10) yields (3.4)

i.e. $\frac{\partial p}{\partial q} \quad \frac{q}{p} \quad = \frac{-1}{p} f(y^*) \left[\frac{\sigma^2}{p} f(y^*) + \mu - y^*\right] > -1.$

This inequality can be verified by substitution.

Appendix B. - Reservation Wages, No Recall

N \ q	1.0	.75	.50	.25	
0	0	0	0	0	
1	900	812	400	105	
2	908	853	602	254	
3	910	865	701	339	
4	910	869	750	406	$\mu = 1000$
5	910	870	775	455	
6	910	871	787	492	$\sigma = 100$
7	910	871	794	520	
8	910	871	797	540	$c = 100$
9	910	871	798	554	
10	910	871	799	566	
11	910	871	799	575	
12	910	871	799	581	
13	910	871	799	585	
14	910	871	799	589	
15	910	871	799	592	
20	910	871	799	598	
∞	910.03	871.33	799.69	599.55	

q / N	1.0	.75	.50		
0	0	0	0	0	
1	990	740	490	240	
2	1025	925	736	418	
3	1043	981	858	554	μ = 1000
4	1055	1008	921	656	
5	1063	1025	957	732	σ = 100
6	1069	1036	979	789	c = 10
7	1074	1044	995	832	
8	1077	1051	1006	864	
9	1079	1056	1014	889	
10	1081	1059	1021	909	
11	1083	1061	1026	924	
12	1084	1064	1030	936	
13	1085	1066	1033	946	
14	1087	1067	1038	954	
15	1088	1068	1040	961	
20	1088	1071	1044	981	
∞	1089.99	1071.56	1048.78	1000.00	

NOTE: y^*_n, N = ∞ IS RESERVATION WAGE FOR SEARCH WITH RECALL FOR ALL SEARCH HORIZONS EXCLUDING N=0.

References

Barron, J.M. (1975) "Search in the Labour Market and the Duration of Unemployment : Some Empirical Evidence", American Economic Review, 65, pp. 934 - 942.

Chalkley, M.J. (1982) "Models of Search in the Labour Market" Warwick Economic Research Paper, No. 206.

Feinberg, R.M. (1977) "Search in the Labour Market and the Duration of Unemployment; Note, "American Economic Review, 67. pp. 1011-1013.

Landsberger, M. and Peled, D. (1977) "Duration of Offers, Price Structure and the Gain from Search", Journal of Economic Theory. 16, pp. 17-37.

Lippman, S.A. and Mc Call, J.J. (1976a) "The Economics of Job Search : A Survey Pt. 1". Economic Inquiry, 14. pp. 155-189.

Lippmann, S.A. and Mc Call, J.J. (1976b) "The Economics of Job Search : A Survey Pt. II." Economic Inquiry, 14, pp. 347-368.

Lippmann, S.A. and McCall, J.J. (1976c) "Job Search in a Dynamic Economy" Journal of Economic Theory, 12, pp. 365-390.

Nickell, S. (1979) "Estimating the Probability of Leaving Unemployment" Econometrica, 47, pp. 1249-1266.