Search Frictions and Labor Market Participation

*** Preliminary and Incomplete ***

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Abstract

This paper explores the link between lengthy search durations and labor market participation. Evidence on worker flows suggests that many workers, particularly women, frequently flow between participation and non-participation. The participation decisions of these workers are sensitive to frictions that reduce job-finding rates, since the frictions may cause the cost of a lengthy job search to outweigh the benefits of an employment spell that is expected to last only a short time. To study this idea, we extend the standard worker search model so that workers face stochastic participation costs. The results show that when job offers are more difficult to come by, workers' participation behavior becomes more polarized: they are more likely either to never participate or to participate relatively consistently. Moreover, the results suggest that the large cross-country differences in average search durations may contribute to the observed cross-country differences in participation rates.

1 Introduction

Modern models of the labor market emphasize worker flows between employment and unemployment. The US labor market is also characterized by significant flows into and out of labor market participation. This is especially true for women. Abowd and Zellner (1985), after adjusting the CPS gross labor flows for several potential reporting errors, find that each month there are flows of women into and out of participation averaging 3.5% of the female labor force (1.9% for men). The flows into and out of the labor force are of roughly equal importance to the flows into the other two states: women who leave employment are more likely to transit to non-participation (a flow rate of 2.2% per month) than to unemployment (1.4% per month); and unemployed women are nearly as likely to transit to non-participation (17%) as to employment (21%).

The fact that these large gross flows coexist with relatively little change in aggregate participation suggests the importance of idiosyncratic shocks to the relative payoffs that individual workers attach to participation and non-participation. In other words, these gross flows suggest that individuals (and women in particular) experience frequent changes in the circumstances that motivate them to alter their labor market status by entering or withdrawing from the labor force. For example, individuals often leave the labor force to care for family members with health problems, to raise children, to pursue educational opportunities, to travel, etc. These withdrawals can last weeks, months,or years. The large gross flows suggest that at any point in time a significant part of the aggregate labor force consists of workers whose attachment to the labor force is short-lived.

In a frictionless world, i.e., a world in which individuals can move costlessly and instantaneously between working and not working, these idiosyncratic reversals in the value of market work relative to nonparticipation would be perfectly matched with flows into and out of the labor market. In a world with frictions, this situation is altered. Reversals in relative payoffs are no longer perfectly mirrored by flows into and out of the labor force. In particular, frictions would be expected to diminish both the flow into and out of the labor force.

This paper seeks to explore the relationship between a specific friction—the arrival rate of job offers—and labor force participation. To do this we extend the standard worker search problem to allow for idiosyncratic shocks to the costs of labor market participation. In the model, participation costs stochastically switch between a high and low value. If a worker chooses to participate they receive random job offers from an exogenous wage distribution that arrive according to a Poisson process. Employment spells end either when an exogenous separation occurs or when participation costs switch to the high value and the worker as a result chooses to leave the labor market.

A worker's optimal search strategy consists of three components: a decision of when to search, a decision of which wages to accept when searching, and a decision of which jobs to retain if participation costs increase. Depending on parameter values, workers' optimal decisions may dictate that they always search, that they search only when participation costs are low, or that they never search. For the cases in which workers do choose to search, their acceptance strategy is characterized by a reservation wage. And if an employed worker experiences an increase in participation costs, the decision about whether to remain employed is also characterized by a reservation wage. We characterize optimal decisions analytically and derive a simple diagram that demonstrates how workers' optimal decisions—about when to search and about reservation wages—are determined.

To examine the impact of increasing frictions we analyze the impact of changes in the offer arrival rate. In accordance with intuition, we show analytically that search frictions have two effects. First, they expand the set of circumstances under which an individual chooses not to participate. Second, it expands the set of jobs that individuals choose to retain when participation costs increase. However, depending upon the distribution of wages and the distribution of individuals across types, the aggregate effect on participation and labor market flows is ambiguous. To explore the issue further we carry out a simulation based on a reasonable parameterization. We find that increasing frictions lead to lower participation and lower labor market flows.

Our analysis focuses entirely on how the labor supply side of the market responds to particular changes. More generally, these results may be particularly relevant to discussions about the effects of different labor market policies such as firing costs, unemployment benefits, and minimum wages on cross-country labor market outcomes. It is frequently noted (see, for example, Pries and Rogerson (2001)), that these policies, which are more common in the more heavily regulated labor markets of Western Europe, often lead to significantly lower offer arrival rates. Our model suggests that this may be associated with lower aggregate participation rates and lower levels of flows into and out of the labor force, as we in fact do observe.[1] Further support for this channel is offered by the fact that it is participation by women in particular, that is significantly lower in countries with longer search durations.

We are not the first to model nonparticipation in a search framework. Andolfatto and Gomme (1996) and Andolfatto, Gomme and Storer (1998) use a three state decision-theoretic search model to analyze differences in aggregate labor market outcomes in the US and Canada in the 1980's. Pissarides (1990) develops a general equilibrium matching model with three states, but in his model there are no flows in and out of the labor market. Kim (2001) and Garibaldi and Wasmer (2003) both extend this model to generate flows into and out of the labor market. Finally, Alvarez and Veracierto (1999) and Veracierto (2003) extend the Lucas-Prescott (1974)island model to allow for nonparticipation. There are several differences between these analyses and ours. Most important for our purposes is that they do not consider heterogeneity in the expected duration for the low participation cost state. Our analysis stresses the importance of this group in affecting how increased frictions influence aggregate participation.

The paper is organized as follows. The next section describes the model. Section 3 analyses optimal behavior and provides a diagrammatic exposition of the optimal decision rules. Section 4 examines some of the the model's comparative statics and section 5 presents a simulation of the model. Section 6 concludes.

2 Model

The model extends the standard worker search problem to consider an individual who faces stochastic costs associated with labor market participation. These stochastic costs may represent stochastic elements of family responsibilities such as care for a child or an elderly family member, stochastic elements of educational commitments, health shocks that affect the disutility associated with working, or simply preference shocks.[2]

[1] Regarding the cross-country evidence on flows into and out of participation, see, for example, Blanchard and Portugal (2001). They show that flows from employment to non-participation are four times higher in the US compared to Portugal.

[2] More generally, the issues that we address would also be relevant for all individuals who find themselves in a situation in which they would like to find employment for a specific duration. This could include workers on temporary layoff, seasonally unemployed

We consider a model in continuous time. An individual seeks to maximize the discounted present value of consumption and leisure net of the costs of labor force participation:

$$\int e^{-rt}(c_t - x_t I_t^E + (z^u - x_t) I_t^U + z^n I_t^N) dt$$

where c_t is consumption at time t, r is the rate of time discount, x_t is the cost associated with labor force participation at time t, z^u is the value of leisure (net of search costs and inclusive of any monetary transfers) while unemployed, and z^n is the corresponding value when the individual is neither working nor searching. I_t^S is an indicator function that takes on the value 1 at time t if the individual is in labor market state S and 0 otherwise, where S can take on the values of E (employed), U (unemployed) or N (not participating). It follows that in state N the individual receives the benefit z^n and incurs no cost, in state U they receive the benefit z^u but also incur the cost x_t, while in state E they simply incur the cost x_t.[3]

We assume that participation costs are stochastic and that they follow a two state process with Poisson arrivals. These costs take values in the set $\{x^g, x^b\}$ with $x^b > x^g$. We refer to the x^b state as the bad state and the x^g state as the good state, since all else equal a worker will always prefer to be in the good state. The probability of transiting into the good state from the bad state will be denoted as p^g and the probability of transiting into the bad state from the good state will be denoted as p^b. These transition rates are independent of the labor market state (i.e., E, U, or N) that the worker occupies.

A worker without a job who chooses to search incurs the participation cost and receives wage offers that arrive according to a Poisson process with arrival rate α and that are drawn from a wage distribution with *cdf* $F(w)$. Wage draws from $F(w)$ are *iid* and lie in the interval $[0, \infty)$. Once a wage is accepted, it remains unchanged until either there is an exogenous separation or the worker chooses to leave the job. Exogenous job separations occur according to a Poisson process with arrival rate s. Workers may choose to leave a job at any point, though it will become evident that the only time workers might elect to leave a job is when the costs of labor force participation

workers and students.

[3]It is straightforward to generalize the setup so that only a fraction of the participation cost is incurred while searching rather than working. Since the analytic results are not affected by this, we have abstracted from this possibility for notational convenience.

increase from the low value to the high value. There is no on-the-job search and there is no recall of past offers.

3 Decision Rules

3.1 Bellman Equations

We formulate the worker's optimal search problem recursively. The worker faces three decisions: if unmatched, whether to search, if searching whether to accept an offer, and if employed whether to vacate the job. As is standard in search problems, if a worker accepts a job in a given state, they will never find it optimal to leave the job in that same state. It follows that the only time that an individual might vacate a job is if their participation costs change.

The worker's state is characterized by the value of his participation costs (x^g or x^b), whether he is currently matched, and, if he is matched, the value of his wage. Let $E^g(w)$ and $E^b(w)$ represent the value to working in the good and bad state respectively when the wage is w. Similarly, let U^g and U^b represent the value to search in the good and bad state respectively, and let N^g and N^b represent the value to non-participation in the good and bad state respectively. Let V^g and V^b represent the maximum value for an unmatched individual in the good and bad states, respectively. The continuous time Bellman equations for the worker's maximization problem are:

$$rE^g(w) = w - x^g + s[V^g - E^g(w)] + p^b \max\{E^b(w) - E^g(w), V^b - E^g(w)\} \quad (1)$$

$$rE^b(w) = w - x^b + s[V^b - E^b(w)] + p^g \max\{E^g(w) - E^b(w), V^g - E^b(w)\} \quad (2)$$

$$V^s = \max\{N^s, U^s\}, s = g, b \quad (3)$$

$$rN^g = z^n + p^b(V^b - N^g) \quad (4)$$

$$rN^b = z^n + p^g(V^g - N^b) \quad (5)$$

$$rU^g = z^u - x^g + p^b(V^b - U^g) + \alpha E_w \max\{E^g(w) - U^g, 0\} \quad (6)$$

$$rU^b = z^u - x^b + p^g(V^g - U^b) + \alpha E_w \max\{E^b(w) - U^b, 0\} \quad (7)$$

E_w denotes the expectation operator with respect to the distribution of wage offers.

It is straightforward to show that these equations define a contraction mapping and hence have a unique solution. Using standard methods one can show that both $E^b(w)$ and $E^g(w)$ are increasing in w. It follows that all decisions about job acceptance and retention will be characterized by reservation wages.

In general, there are several different qualitative forms that the solution may take. The individual may search in both the good and the bad state, may never search, or may choose to search onlyin the good state. If we are interested in flows into and out of participation, then the last case is the more interesting one. Not surprisingly, we will see that if it is optimal to search in the bad state then it is also optimal to search in the good state, implying that if the individual only searches in one state it will be the good state.

In what follows we provide a simple diagrammatic exposition of the optimal decision rules, including both the decision of when to search and the relevant reservation values. To do this we proceed in two steps. First we characterize optimal reservation values taking the decision of when to search as given. Then we determine the optimal search behaviorgiven these reservation rules.

3.2 Analysis of Three Cases

In this subsection we characterize optimal solutions taking as given the decision of when to search. The first case assumes search occurs only in the good state, the second case assumes that search occurs in both states and the third case assumes that search never occurs. After considering the three cases we show in the next subsection how they can be combined to provide a full characterization of the optimal decision rule.

3.2.1 Case 1: Search Only in the Good State

In this subsection we derive optimal decision rules assuming that the individual searches only in the good state. The optimal decision in this case is two dimensional: the worker makes a decision regarding which job offers to accept when searching, and which jobs to vacate if the state goes from good to bad. Since the value of employment is increasing in the wage, both decisions will be characterized by reservation values. We let w^a and w^r denote the reservation acceptance wage and the reservation retention wage, with the interpretation that w^a is the reservation wage for accepting offers in the good state, and w^r is the reservation wage for retaining offers in the bad state. It follows that these two wages satisfy $E^g(w^a) = U^g$ and $E^b(w^r) = N^b$.

We show that the optimal choices of w^r and w^a can be represented as the unique intersection of an upward sloping curve and a downward sloping curve in $w^a - w^r$ space. One of these curves can be thought of as expressing the optimal reservation wage for job acceptance given a value for the reservation wage for retention, and the other can be thought of as describing the optimal reservation wage for the retention decision given a reservation wage for the job acceptance decision. The first we will call the job acceptance (JA) curve and the second we will call the job retention (JR) curve.

The strategy for deriving these two curves is standard–we derive expressions for the relevant value functions in terms of the two decision rules w^a and w^r and then substitute for the value functions in the two equations that define the reservation values.

We begin by deriving the job acceptance curve. Of particular interest is the value $E^g(w) - U^g$ since this value is critical in terms of deciding which wages to accept. If $w^a < w^r$ it is easy to show that $E^g(w) - U^g$ is piecewise linear. In particular, one can show that for $w \geq w^r$

$$E^{g\prime}(w) = \frac{1}{r+s} \tag{8}$$

while for $w^a \leq w \leq w^r$

$$E^{g\prime}(w) = \frac{1}{r+s+p^b} \tag{9}$$

The difference in the two slopes stems from the fact that the separation rate for $w \geq w^r$ is s, whereas for $w^a \leq w \leq w^r$ it is $s + p^b$. Intuitively, the marginal value of a higher wage is smaller for $w^a \leq w \leq w^r$ because the job is not expected to last as long—these jobs will be terminated if the state changes to the bad one.

It follows that for $w^a \leq w \leq w^r$:

$$E^g(w) - U^g = \frac{1}{r+s+p^b}(w - w^a) \tag{10}$$

while for $w \geq w^r$:

$$E^g(w) - U^g = \frac{1}{r+s+p^b}(w^r - w^a) + \frac{1}{r+s}(w - w^r). \tag{11}$$

Now, substitute (1) and (6) into the equation $E^g(w^a) = U^g$ to obtain:

$$w^a = z^u - p^b \max[E^b(w^a) - N^b, 0] + \alpha E_w \max\{E^g(w) - U^g, 0\} \tag{12}$$

In the region where $w^r \geq w^a$, we have that $E^b(w^a) \leq E^b(w^r) = N^b$ and equation (12) becomes

$$w^a = z^u + \alpha E_w \max\{E^g(w) - U^g, 0\} \tag{13}$$

Using (11), equation (13) can be rewritten as

$$w^a = z^u + \alpha \left[\int_{w^a}^{w^r} \frac{(w - w^a)}{r + s + p^b} dF(w) + \int_{w^r}^{\infty} [\frac{(w^r - w^a)}{r + s + p^b} + \frac{(w - w^r)}{r + s}] dF(w) \right] \tag{14}$$

This is an expression in w^a, w^r, and primitives. It is convenient to think of this curve as describing the optimal choice of w^a given an optimal choice of w^r, though in fact all it really does is describe the locus of (w^a, w^r) points that are consistent with the optimal job acceptance decision. The left hand side is trivially increasing in w^a, and it is easy to show that the right hand side is decreasing in w^a and w^r. Thus, this equation describes a downward sloping relationship between w^a and w^r. Intuitively, in a standard search model if the separation probability goes up the worker becomes more willing to accept lower paying jobs. In this model the effect is somewhat more subtle, but an increase in w^r also implies that jobs last less time on average and leads to a lower value of w^a.

Next we partly characterize the JA curve. First, we solve for one specific point on the JA curve by looking for a point on the curve that has $w^a = w^r$. In this case the individual never vacates a job once accepted and from (14) it is apparent that the value of w^a satisfies:

$$w^a = z^u + \alpha \int_{w^a}^{\infty} \frac{(w - w^a)}{r + s} dF(w)$$

We denote this value by $\hat{w}^a$. The above calculation implies that the JA curve intersects the 45-degree line at $\hat{w}^a$.

We can also solve for the (asymptotic) value of w^a that the JA curve approaches as w^r becomes arbitrarily large. Letting w^r become infinite corresponds to the case where *all* jobs are vacated if the bad state occurs. This value of w^a satisfies:

$$w^a = z^u + \alpha \int_{w^a}^{\infty} \frac{(w - w^a)}{r + s + p^b} dF(w)$$

We denote this value by $\bar{w}^a$and note that it clearly satisfies $0 \leq \bar{w}^a \leq \hat{w}^a$. Though it is not important for our analysis, it is also straightforward to show that the JA curve is convex between $\bar{w}^a$ and $\hat{w}^a$.

Thus far we have only considered the region in which $w^r \geq w^a$. However, it is easy to extend the JA curve beyond this region. Suppose that we let w^r take on a value below $\hat{w}^a$. How would this affect the optimal acceptance strategy? With $w^a = w^r = \hat{w}^a$ the individual is not vacating any jobs when the state turns bad. If we consider values of $w^r < \hat{w}^a$ then this remains true, and hence lowering w^r at this point is effectively identical to keeping w^r equal to $\hat{w}^a$. It follows that the JA curve is completed by adding a vertical section between the 45-degree line and the w^a axis, as depicted in figure 1.

Next we derive the JR curve, which is based on the condition $E^b(w^r) = N^b$. Using (2) and (5) to substitute into this condition, we get:

$$w^r = z^n + x^b - p^g \max\{E^g(w^r) - U^g, 0\} \tag{15}$$

Once again we begin by considering the region in which $w^r \geq w^a$, which implies that $E^g(w^r) - U^g > E^g(w^a) - U^g = 0$. Together with (9), this implies

$$E^g(w^r) - U^g = \frac{w^r - w^a}{r + s + p^b}. \tag{16}$$

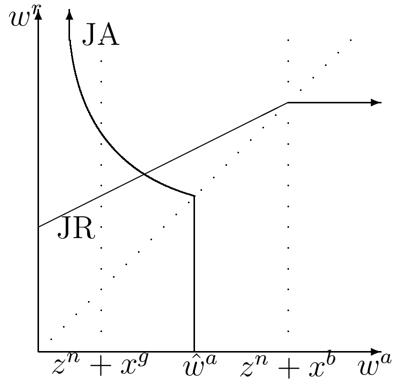
Substituting for $E^g(w^r) - U^g$ using equation (15) and rearranging gives:

$$w^r = \frac{r + s + p^b}{r + s + p^b + p^g}(z^n + x^b) + \frac{p^g}{r + s + p^b + p^g} w^a \tag{17}$$

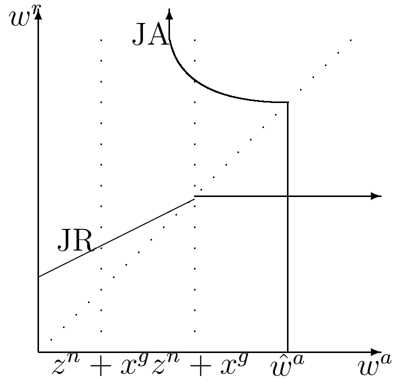
This expression defines the JR curve. It is convenient to think of this curve as describing the optimal choice of w^r given a value of w^a though in fact it really just gives pairs of points (w^a, w^r) that are consistent with the optimal retention decision. It is apparent that the JR curve is upward sloping. Intuitively, the more attractive nonparticipation becomes in the bad state, the higher the reservation retention wage will become, and w^a proxies for the value of nonparticipation. From the above expression we can say quite a bit more about the JR curve: it is a straight line that intersects the w^r axis above the origin and has slope less than one. It follows that it necessarily intersects the 45-degree line, and that at this point of intersection we have $w^a = w^r = z^n + x^b$.

The above derivation also assumed that we were in the region $w^r \geq w^a$. Once again, however, we can easily extend it beyond this region. In particular, consider the point where the JR curve intersects the 45-degree line. As we move to the right of the 45-degree line, it is no longer true

Case 1: Search only in good state



Case 2: Always Search



Case 3: Never Search

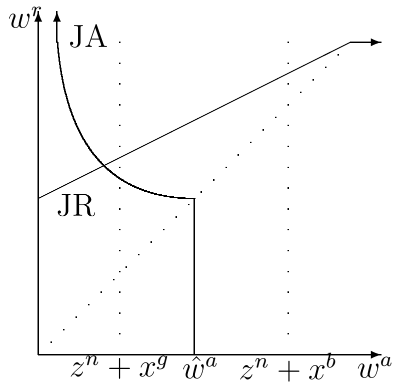


Figure 1: Determination of w^a and w^r

that $E^g(w^r) - U^g > 0$. Thus, from (15) it is easy to see that in this case $w^r = z^n + x^b$. The JR curve is thus as pictured in Figure 1.

It follows from Figure 1 that the $JA$and JR curves intersect at most once. We now consider the relationship between this intersection and the optimal solution to the worker's search problem. To do this we will have to consider two other cases: the case in which the worker searches in both states, and the case in which the worker never searches.

3.2.2 Case 2: Always Search

Assuming that the individual searches in both states, we can show that the worker's optimal search strategy is defined by a single, state-independent reservation wage that we denote simply as w^a. Moreover, in terms of the determination of the reservation wage it is the same as the standard worker search problem in which there are no costs of participation.[4] Using standard arguments one can show that the reservation wage satisfies:

$$w^a = z^u + \frac{\alpha}{r+s} \int_{w^a}^{\infty} (w - w^a) dF(w) \tag{18}$$

Note that the solution to this equation is the value that we previously denoted as $\hat{w}^a$, which is the point at which the JA curve intersects the 45-degree line..

Combining equation (18) with equations (6) and (7) and substituting $V^s = U^s$ for all s, one can derive the following expressions for U^b and U^g:

$$rU^b = \hat{w}^a - [\frac{r+p^b}{r+p^b+p^g} x^b + \frac{p^g}{r+p^b+p^g} x^g] \tag{19}$$

$$rU^g = \hat{w}^a - [\frac{p^b}{r+p^b+p^g} x^b + \frac{r+p^g}{r+p^b+p^g} x^g] \tag{20}$$

Next we ask whether it is optimal for a worker to search in both states. The principle of improvability tells us that it is enough to consider single deviations from the decision rule just derived. Hence, it is enough to ask if the individual can be made better off by not searching in the good state or in the bad state, holding the reservation wage constant. (We will see that it is sufficient to check this condition for the bad state.) The approach we follow

[4] Intuitively, if the worker always searches the participation costs are always incurred and do not affect decision making at the margin. Of course, payoffs are affected by the presence of the stochastic participation costs.

is to solve for the loci of points in parameter space for which the individual is indifferent between searching and not searching in the bad state, holding the reservation wage constant, and therefore separate parameter space into two regions: one where searching in both state is preferred and one where searching only in the good state is preferred.

If the individual were to search only in good times, then the value of nonparticipation in the bad state is given by

$$rN^b = z^n + p^g(U^g - N^b) \tag{21}$$

which implies

$$N^b = \frac{z + p^g U^g}{r + p^g} \tag{22}$$

Using (22) with equations (19) and (20) and imposing that $N^b = U^b$ we obtain:

$$\hat{w}^a - x^b = z^n \tag{23}$$

(Similarly, we note that $N^b > U^b$ if and only if $\hat{w}^a - x^b < z^n$.) Since $\hat{w}^a$ is implicitly a function of the model's primitives, this expression only involves the model's primitives. Substituting this into the expression for $\hat{w}^a$ gives:

$$z^n = z^u - x^b + \alpha \int_{z^n + x^b}^{\infty} \frac{w - z^n - x^b}{r + s} dF(w). \tag{24}$$

which defines the loci of primitives for which the individual is indifferent between searching and not searching in the bad state, for a given reservation wage w^a. Recall that the parameter z^n does not enter into the determination of $\hat{w}^a$, so that one way to interpret the condition in equation (23) is that it is optimal to not search in the bad state if and only if z^n is greater than $\hat{w}^a - x^b$. This condition has a natural interpretation. It says that the individual will be just indifferent between searching and not searching in the bad state if the reservation wage net of participation costs is exactly equal to the flow value of nonparticipation. Perhaps surprisingly, this condition does not explicitly contain z^u. The influence of z^u is exerted entirely through its effect on $\hat{w}^a$: holding all else equal a higher value of z^u will increase $\hat{w}^a$ and hence increase the left hand side of equation (23), thereby making it more attractive to search in bad times.

Note that we could also have asked if it were optimal to deviate from the strategy of searching in the good state. This would have produced a condition equivalent to that in equation (23), except with x^g in place of x^b. It follows that if it is optimal to search in the bad state it is also optimal to search in the good state.

3.2.3 Case 3: Never Search

If an individual chooses never to search, then the problem becomes trivial. There are no additional decisions to make and as a result the flow utility will always be equal to z^n. It is then a simple matter to determine if it is better to search in the good state. We simply need to compare the flow value of searching in the good state, rU^g, with z^n. Proceeding as earlier it is possible to derive an expression for U^g in terms of the decision rules. This expression is:

$$rU^g = \frac{r + p^g}{r + p^g + p^b}[w^a - x^g] + \frac{p^b}{r + p^g + p^b} z^n$$

As the expression shows, U^g is dependent only on the primitives and w^a; the value of w^r does not enter this expression. Also, the flow value of search is a convex combination of the reservation wage net of participation costs and leisure. This expression should remind the reader of the similar expression derived in the previous subsection. It is clear from this expression that $rU^g - z^n$ is positive (search in the good state is optimal) if and only if $w^a > z^n + x^g$. This expression is exactly analogous to the expression we derived for when search is optimal in the bad state.

3.3 Optimal Solution

We are now able to fully characterize the optimal solution in terms of the JA and JR curves. Suppose we have an intersection that lies on or above the 45-degree line. It is easy to show that this solution provides higher utility than that generated by searching always. To see this note that if the intersection occurs above the 45-degree line, then the value of w^a at which the JA curve hits the 45-degree line, i.e. $\hat{w}^a$, is less than the value at which the JR curve hits the 45-degree line, i.e., $z^n + x^b$. Of course, as we showed before, $\hat{w}^a < z^n + x^b$ implies that it is not optimal to search in the bad state. If the intersection of the JR and JA curves occurs on the 45-degree line, then the individual is exactly indifferent between searching in the bad state and not searching in the bad state. Finally, if the intersection occurs below the

	α	p^b	p^g	s	r	z^u	z^n	x_b	x_g
w^a	+	−	+	−	−	+	−	−	0
w^r	+	+	−	?	?	+	+	+	0

Table 1: Impact of parameters on w^r and w^a

45-degree line then we know that the optimal strategy is to search in both states.

If the intersection lies above the 45-degree line and has $w^a > z^n + x^g$ then the optimal solution is to search only in the good state and to use the reservation values corresponding to the intersection of the JA and JR curves. Otherwise, the optimal strategy is to never search. Figures 1-3 show the three possible outcomes.

4 Comparative Statics

We report three types of comparative statics results for the model. The first type of result considers what happens to optimal reservation values assuming no change in the decision of when to search. The second type of result considers what happens to the regions which define the optimal strategy of when to search. And the third type of result considers how a change in arrival rates will affect average flows among the three labor market states.

4.1 Comparative Statics for Reservation Values

The model allows us to analytically sign how most of the model's parameters will affect the optimal reservation values w^a and w^r. Table 1 summarizes the impact that the model's parameters have on the two reservation wages, assuming that the parameters are in the interior of the set that assures that workers search only in the good state.[5] Most of the results here can be determined by simply examining how the parameters shift the JA curve (represented by equation (14)) and the JR curve (represented by equation (17)), although some require a bit of algebra.

[5]If the worker searches in both states then the problem reduces to that of the standard worker search problem, so we do not report the comparative statics results for how various parameters affect $\hat{w}^a$.

These results are largely intuitive and probably do not require any extensive discussion. However, since we will be concerned with the impact of frictions as captured by arrival rates, we discuss the effect of changes in α, and since the stochastic participation costs are the novel feature of the model we also discuss the effect of changes in p^g and p^b.

Diagrammatically, an increase in α does not affect the JR curve, while it shifts the JA curve to the right, leading to increases in the optimal values of both w^a and w^r. Intuitively, when wage offers are easier to come by, workers can afford to be more selective in the wages they accept, thereby leading to an increase in w^a. Moreover, because wage offers are more plentiful, the value of being unemployed is higher, thereby raising the value of nonparticipation in the bad state and raising the reservation retention wage as well. Intuitively, when jobs are easier to come by, there is less reason to cling to a current job.

Next consider changes in p^b and p^g. An increase in p^b causes the upward sloping portion of the JR curve to become flatter, but leaves the intersection with the 45-degree line unchanged, and causes the JA curve to shift to the left. Diagrammatically, the net effect is a decrease in w^a, while the change in w^r would appear to be ambiguous. However, one can show algebraically that the net effect on w^r is unambiguously positive. Intuitively, w^a is decreasing in p^b since workers have less reason to hold out for a high-paying job if they don't expect to keep the job for long. Because there are opposing effects on w^r, the intuition is not so clear. On the one hand, a higher value of p^b reduces the value of search, thereby lowering the value of nonparticipation, and leading to a lower value of w^r. On the other hand, an increase in p^b means that a worker will spend more time in the bad state on average and hence there are higher expected costs associated with retaining a job. Even though the flow costs of participation do not increase, spending more time in the bad state is like having higher costs to participation. What the algebra reveals is that this second effect dominates.

An increase in p^g causes the upward sloping portion of the JR curve to become steeper, but leaves the intersection with the 45-degree line unchanged. The JA curve is unaffected. Consequently, w^a increases and w^r decreases. Intuitively, workers are more likely to hang on to matches when the state turns bad (w^r lower) if on average spells of the bad state are shorter. The movement down the JA curve to a higher w^a reflects the fact that if matches are likely to last longer, then workers become more selective.

4.2 Comparative Statics for Search Decisions

We now consider the second type of comparative static result—how do changes in parameters affect the decision of whether to search. Our approach is as follows. In each case we consider a worker who is initially indifferent between two different search strategies and then we ask how an increase in a given parameter will influence their decision. Consider first the decision regarding whether to search in the bad state. The curve which describes the manifold of indifference in parameter space between searching always and searching only in the good state is $\hat{w}^a = z^n + x^g$. Recall that $\hat{w}^a$ is independent of the parameters describing the stochastic participation cost structure: p^g, p^b, x^g, and x^b, as well as the flow value of nonparticipation, z^n. Additionally, as in a standard search model it is easy to show that $\hat{w}^a$ is increasing in α and z^u, and decreasing in s and r. It follows that increases in z^n, x^g, s, or r will decrease the region of participation in the bad state, and that increases in α and z^u will increase the region of participation in the bad state.

Next we consider the decision of whether to participate in the good state, which is the same as asking if the individual should ever participate. In this case the manifold of indifference in parameter space between searching and not searching in the good state is described by $w^a = z^n + x^b$, where w^a is the reservation acceptance wage derived from the intersection of the JA and JR curves. The comparative statics exercise on w^a is completely summarized by the results in table 1, thereby making it fairly easy to determine the effects on search in the good state. In particular, it follows that increases in α, p^g, and z^u increase the region of participation in the good state, while increases in p^b, s, r, z^n, and x^g all decrease the region of participation in the good state.

4.3 Comparative Statics on Worker Flows

Because we will be particularly interested in the effect of decreases in α, it is of interest to consider the various channels though which a decrease in α influences the dynamics of participation, i.e., flows into and out of the labor force and the fraction of the population that does participate. In carrying out this analysis we will implicitly assume that there is a distribution of individuals across parameter values.

The first set of comparative statics results implied that w^a and w^r will decrease as α decreases. The effect of these changes on flows into and out of the labor force are ambiguous. Consider first those individuals with characteristics such that they search only in the good state in both situations. A decrease in α has several consequences for the flows of these individuals. First, it influences the probability that a searching individual becomes employed, through its effect on both the arrival rate and the reservation wage. In general this has an ambiguous effect on the probability of becoming employed, though it is known in the standard search model that log-concavity of the wage distribution guarantees that the probability of becoming employed will decrease if α decreases. Holding all else constant, this will decrease the amount of time spent in the employed state. Holding all else constant, if the probability of being employed is lower, then the probability of leaving the labor market when the bad state occurs increases, since the worker always leaves when this state occurs if they are unemployed. Second, by influencing the reservation wage w^a, the decrease in α alters the distribution of accepted wages. Hence, even though w^r decreases, it does not follow that employed workers are less likely to transit to out of the labor force. Overall, for this group the effect of the changes in reservation wages on flows into and out of the labor force is ambiguous. It also follows that the overall effect of the changes in the reservation wages on the average time spent in the labor force is also ambiguous.

Next we consider the implications of the changes on when an individual searches. Lower arrival rates unambiguously imply that search will at most stay the same for a given worker state–any unmatched worker who was initially indifferent about searching will now search less often. However, the implication for flows into and out of the labor force is ambiguous. Workers initially indifferent between searching all the time and searching only in the good state will now search less but will have more transitions into and out of the labor force. On the other hand, individuals initially indifferent between searching only in the good state and never searching will now search less and will have fewer transitions into and out of the labor force.

Combining the two sets of results, it is clear that we cannot say unambiguously what happens to the flows into and out of the labor force or the average amount of time spent in the labor force for a given individual when frictions increase. In the next section, we will carry out some simulations to further explore these effects.

Lastly, we consider how search behavior would vary across individuals in a population if individuals were identical except for variation in the flow value of nonparticipation, z^n. This is of interest since in some contexts z^n has been understood to be the primary determinant of whether individuals ever participate, with participation less likely among workers who place a higher value on leisure (see Pissarides (2000)). Analogous arguments to those just made will imply that there are two reservation values of z^n with the property that for z^n higher than the larger value individuals never search, for z^n in between the two values individuals search only in the good state, and for z^n less than the smaller value individuals always search. In this case as well, if frictions increase (i.e., α decreases) both cutoff values will decrease. Though this effect is present in our model, our quantitative analysis will focus on the new channel that we stress, between frictions and the stochastic nature of participation costs.

5 Quantitative Analysis

Thus far our focus has been to obtain an analytic characterization of individual decision rules and to derive qualitatively how optimal decisions may be respond to changes in various parameters. Of particular interest was the effect of a change in offer arrival rates. Our previous analysis suggested that individual worker characteristics describing the expected duration of a spell of participation was very important in determining how a given worker would respond to this change. In this section we explicitly consider the situation of a large number of workers that are heterogeneous with respect to this parameter and focus on quantifying the aggregate response of this group of workers to a change in offer arrival rates. To do this we will find a parameterization of our model that can mimic in a reasonable way some salient features of labor market dynamics for the US economy during the 1990's. We then ask how outcomes would be affected if the job arrival rate were to decrease holding all else constant. We proceed toward this goal in several steps. In the next subsection we describe the data that we use in parameterizing the model. We then describe the parameterization that we use. Following this we preent results for our baseline case, and we close with a discussion of sensitivity analysis.

5.1 Data

All of the data that we use to parameterize the model corresponds to the period 1990-2000. While data are available for a longer time period, we decided to use one subperiod because several of the series do have significant trends. At the same time we wanted to choose a period that was sufficiently long to represent average conditions rather than those that reflect one particular phase of the business cycle. We also restrict attention to individuals between the ages of 16 and 64 since Social Security is likely to be a significant factor for individuals 65 and older and our model does not include this program.

At its core our model is a model of how individuals transit among labor market states. It follows that data on labor market transitions will play a key role in parameterizing the model. Raw data on gross flows are commonly thought to contain many spurious transitions (see, e.g., Clark and Summers (1979), Abowd and Zellner (1985) and Poterba and Summers (1986)). To deal with this apply the Abowd-Zellner (1985) correction factors to the raw CPS data to generate the transition rates that we use in our analysis.[6]

The transition rates among all three labor market states are sufficient to compute many aggregate statistics of interest. However, as we will see below, although our model will not be able to perfectly mimic these transition rates, we do want to require that it match certain aggregate statistics, so we report these statistics explicitly as well. In particular, we will report the average fraction of the population that belongs to each of the three states: employed, unemployed and not in the labor force, as well as the average duration of unemployment as reported by the CPS. [7]

As we will see, the statistics just mentioned will not help us determine the extent of heterogeneity among workers–in particular, the presence of heterogeneity will not be important in getting the model to match the various statistics just mentioned. In order to determine the amount of heterogeneity we will introduce one peice of data that relates explicitly to the distribution of worker types. In particular we use data on the distribution of annual weeks worked. This information is taken from the March Supplement of the CPS. The raw data for the weeks worked distribution exhibits substantial "heaping", with large spikes at 26 weeks and at responses that are multiples of ten. To deal with this, we smoothed the distribution for weeks 1 to 51 by fitting a cubic polynomial. We then used the smoothed distribution to

[6]We thank Robert Shimer for supplying us with this gross labor flows data.

[7]The CPS reports the average duration of a point-in-time sample of incomplete spells. If the completion of spells can be described by a Poisson process, then the average duration of incomplete spells is equal to the expected duration of a new spell, which is also equal to the average from a sample of completed spells observed over a period of time. The model's average duration of unemployment is computed in an parallel manner.

compute averages for the four intervals reported below in table 3, in addition to using the proportions reporting zero and 52 weeks of work.

5.2 Calibration

For the calibration we set a unit of time to correspond to one week. We set the discount rate so that it corresponds to an annual real interest rate of 4%. For our baseline case we set the wage distribution to be a uniform distribution on the interval $[0, 1]$. Setting the maximum wage to be one can be interpreted as a normalization since a proportionate increase in all payoffs leaves the model's implications for dynamics unchanged.[8] We experimented with other distributions such as a normal and found there to be little difference for the results that we focus on. There are seven remaining parameters: s, α, p^g, x^g, x^b, z^n, z^u, in addition to the distribution to describe the heterogeneity in p^b. Only the relative participation cost matters, so we set $x^g = 0$, leaving six parameters and the one unknown distribution. While there is little a priori information that one might bring to bear to suggest a reasonable distribution for the values of p^b, we found that an exponential distribution worked well in allowing us to match the weeks worked distribution. Since this is a parsimonious distribution, in what follows we restrict attention to this class. We set the lower endpoint of the distribution to be .0005, which corresponds to an expected duration of 40 years.[9]

The goal of the calibration was to find values for the model's parameters such that in steady state the aggregate statistics for the model would match the transition rates and weeks worked distribution described in the previous subsection. We note that none of the remaining parameters maps directly into any of the transition rates that we want to match, so all parameters must be determined jointly. Moreover, and not surprisingly in view of earlier work such as Andolfatto and Gomme (1996), Andolfatto, Gomme and Storer (1998) and Garibaldi and Wassmer (2003), our model is not able to match all of the transition rates. In particular, it has trouble matching flows from out of the labor force into employment and from unemployment into out of the

[8] Above, it was assumed that the wage offer distribution had no upper bound because it facilitated the analysis. The assumption here of a finite upper bound does not affect the nature of the results in any qualitatively important way.

[9] We do not truncate the distribution at any upper bound, but from a practical perspective we note that above a certain level individuals will choose to never participate so that it would not matter if we did truncate at some high level.

Parameter	Description	Value
r	Discount rate	$1.04^{1/52}-1$
z^n	Payoff from non-participation	0.72
x_b	Participation cost in bad state	0.8
x_g	Participation cost in good state	0
z^u	Payoff from unemployment	0.1
α	Wage offer arrival rate	0.35
$F(w)$	Wage offer distribution	Uniform [0,1]
s	Exogenous separation rate	0.00215
p^g	Probability of switch to good state	0.045
p^b	Probability of switch to bad state	(various)
$H(p^b)$	Distribution over values of p^b	Exponential

Table 2: Parameter values for simulation

labor force. Each of the papers just mentioned also shares this difficulty.[10] We elaborate on this in more detail below. While one possibility would be to modify the model to better capture thee flows, the approach we follow here is to choose parameters such that we match the aggregate shares for the three labor market states, the average duration of unemployment, the following four labor market transition rates: e-u, u-e, e-n, and n-u, and the statistics for the weeks worked distribution. Of course, it should be noted that if one wants to match the fraction of the population in each labor market state while missing on some transition rates it is likely that the remaining two transition rates cannot be matched either.

Table 2 shows the parameter values used for the baseline simulation.

Table 3 shows how the steady state of the model is able to mimic the same statistics for the US.

A few remarks regarding the calibration are in order. As previously noted, we lean heavily on the empirical weeks worked distribution to guide the parameterization of the distribution over values of p^b. It is worthwhile to note that in fact very little (or no) heterogeneity in p^b would be necessary if we chose to exclude the weeks worked distribution from the list of statistics

[10]Kim (2001) is able to match the flow from out of the labor force into employment by assuming that workers who are out of the labor force still receive offers, although at a lower rate than those who are unemployed.

	U.S. data	Model
Fraction employed	0.7173	0.7071
Fraction unemployed	0.0465	0.0426
Fraction not participating	0.2362	0.2455
Unemployment rate	0.0609	0.0629
Ave. search duration (weeks)	15.44	15.11
0 weeks worked	0.2018	0.2015
1-13 weeks worked	0.0451	0.0307
14-26 weeks worked	0.0480	0.0491
27-39 weeks worked	0.0634	0.0708
40-51 weeks worked	0.0831	0.0843
52 weeks worked	0.5587	0.5635
Monthly e-u hazard rate	0.0113	0.0086
Monthly u-e hazard rate	0.2339	0.2599
Monthly n-u hazard rate	0.0376	0.0333
Monthly u-n hazard rate	0.1443	0.0313
Monthly e-n hazard rate	0.0153	0.0120
Monthly n-e hazard rate	0.0434	0.0073

Table 3: Comparison of baseline model with US data

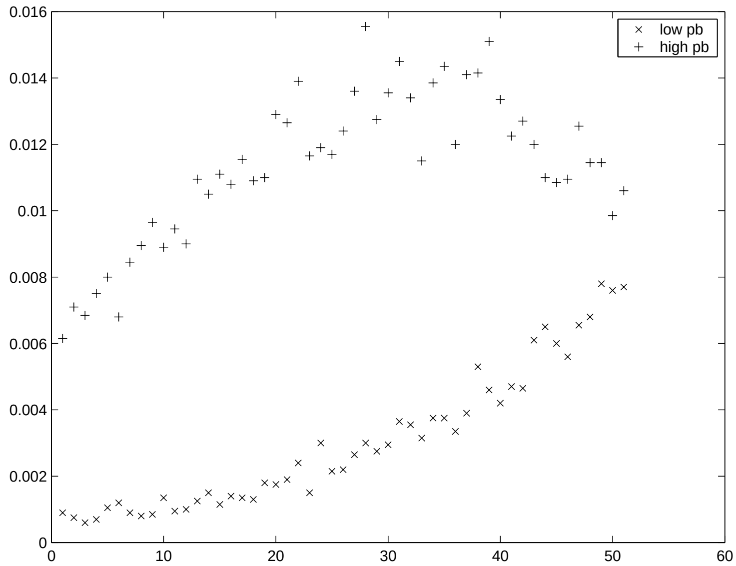


Figure 2: Weeks worked distribution for lowest and highest p^b

to be matched. Conversely, without heterogeneity in p^b, the model cannot simultaneously match the weeks worked distribution, the employment, unemployment and non-participation ratios, and the various transition rates. To understand how the weeks worked distribution helps us parameterize the distribution of individuals over values of p^b, it is useful to note that workers with high values of p^b are much more likely to flow into and out of non-participation, and thus are much more likely to report low numbers of weeks worked. For example, at the lowest value of p^b in the calibrated model, 82.7% of workers report 52 weeks worked and 0.6% report 0 weeks worked. In contrast, at the highest value of p^b at which workers still participate (i.e. $\bar{p}^b$), only 34.7% report 52 weeks worked while 5.3% report 0 weeks worked. Figure 2 shows that there is a similar disparity for weeks 1 to 51 of the weeks worked distribution. While intermediate values of p^b generate a weeks worked distribution closer to the empirical weeks worked distribution, the other statistics of interest miss the mark with those intermediate values of p^b. We conclude that a mix of high-p^b workers and low-p^b workers is necessary to match the empirical weeks worked distribution (reported in the first column of table 3).

As previously noted, we restrict ourselves to an exponential distribution, so that we have only one parameter to choose. A high rate of decay for the exponential distribution would mean that a large part of the population has

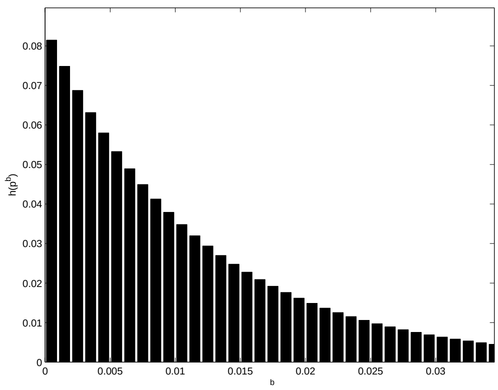


Figure 3: The fraction of individuals with transition probability p^b.

low values of p^b, whereas a low rate of decay will mean that the population is more evenly spread over the different values of p^b. Figure 3 shows the distribution used for the results in table 3.

Next we examine the extent to which the model is able to match the data. As table 3 indicates, the assumed distribution over p^b is able to match quite well the weeks worked distribution. The model also matches well the unemployment, employment, and non-participation rates and the average duration of unemployment spells. Success in matching the various hazard rates, however, is somewhat mixed. While the model does fairly well with the *u-e*, *n-u*, *e-u*, and *e-n* hazard rates, it misses by a nontrivial amount the *u-n* and *n-e* hazard rates. With regard to the *u-n* hazard rate, there are at least two possible explanations for the model's difficulty in matching the data. First, it is possible that the Abowd-Zellner correction factors do not fully adjust for the spurious transitions between unemployment and non-participation, and thus the data overstate the importance of these transitions. Second, the model may not properly account for workers who spend some time in unemployment after leaving a job—perhaps to collect unemployment benefits—before entering non-participation.

There are several comments to make with regard to the inability of the model to match the *n-e* hazard rate. The nature of the model is such that there are actually no worker flows directly from non-participation to employment. Nevertheless, the non-zero hazard rate for the model results from an attempt to determine how much of the n-e flow in the data could be attributed to time aggregation. That is, workers who report being non-participants in one month, then begin search and find a job before being interviewed the following month, will result in an n-e transition when in fact both n-u and u-e transitions have occurred. Thus, the n-e hazard rate reported for the model represents those workers in the model who flow from n to u to e in less than four weeks and thus would be recorded as n-e transitions. Clearly, the results indicate that this time aggregation problem can account for a very small amount of the n-e transitions found in the data. The remaining discrepancy between the data and the model probably reflect the fact that in reality the distinction between non-participation and unemployment is not so clear-cut as it is assumed to be in the model. In reality, there are likely many non-participants who are not actively searching for a job, but who would be willing to accept a job (and indeed do) were they somehow to encounter an offer. (See e.g., Card and Ridell (1998) for an empirical analysis of active and passive searchers.)

5.3 Results

With the baseline model calibrated to US data, we now examine the consequences of a decline in α. Table 4 displays what happens to many statistics of interest when the offer arrival rate is cut in half.

The drop in the non-participating population—nearly 10 percentage points—is the result that most stands out in table 4. To understand the cause of this, it is helpful to look at the behavior of individuals conditional on different values of p^b, shown in the upper left panel of figure 4. There are two important factors that impact the overall participation rate. First, for workers with values of p^b such that they do participate, the reduction in α actually increases the fraction of time that they participate. When offers become scarcer, these workers are more inclined to cling to an existing job even when participation costs rise. This can also be seen in the upper right panel of figure 4, which shows that for a given value of p^b, workers flow out of participation at a lower rate when α decreases. These lower flows into and out of non-participation can also be seen in the transition rates listed in table 4. Second, the reduction in α decreases the range of values of p^b for which workers do participate—i.e. $\bar{p}^b$ falls from 0.195 when $\alpha = 0.35$ to 0.115 when $\alpha = 0.175$—as can be seen in figure 4 by the point at which participation rates drop to zero. Clearly, this works to reduce the overall participation rate, since the mass of workers between the two values of $\bar{p}^b$ do participate for $\alpha = 0.35$ (though not as frequently as workers with lower values of p^b). Of course, the overall decline in participation makes evident that the second factor clearly

	Baseline model: $\alpha = 0.35$	High frictions: $\alpha = 0.175$
Fraction employed	0.7071	0.6033
Fraction unemployed	0.0426	0.0545
Fraction not participating	0.2455	0.3422
Unemployment rate	0.0629	0.0827
Ave. search duration (weeks)	15.11	25.31
0 weeks worked	0.2015	0.3360
1-13 weeks worked	0.0307	0.0210
14-26 weeks worked	0.0491	0.0319
27-39 weeks worked	0.0708	0.0457
40-51 weeks worked	0.0843	0.0560
52 weeks worked	0.5635	0.5094
Monthly e-u hazard rate	0.0086	0.0092
Monthly u-e hazard rate	0.2599	0.1573
Monthly n-u hazard rate	0.0333	0.0119
Monthly u-n hazard rate	0.0313	0.0202
Monthly e-n hazard rate	0.0120	0.0057
Monthly n-e hazard rate	0.0073	0.0013

Table 4: Impact of increase in search frictions

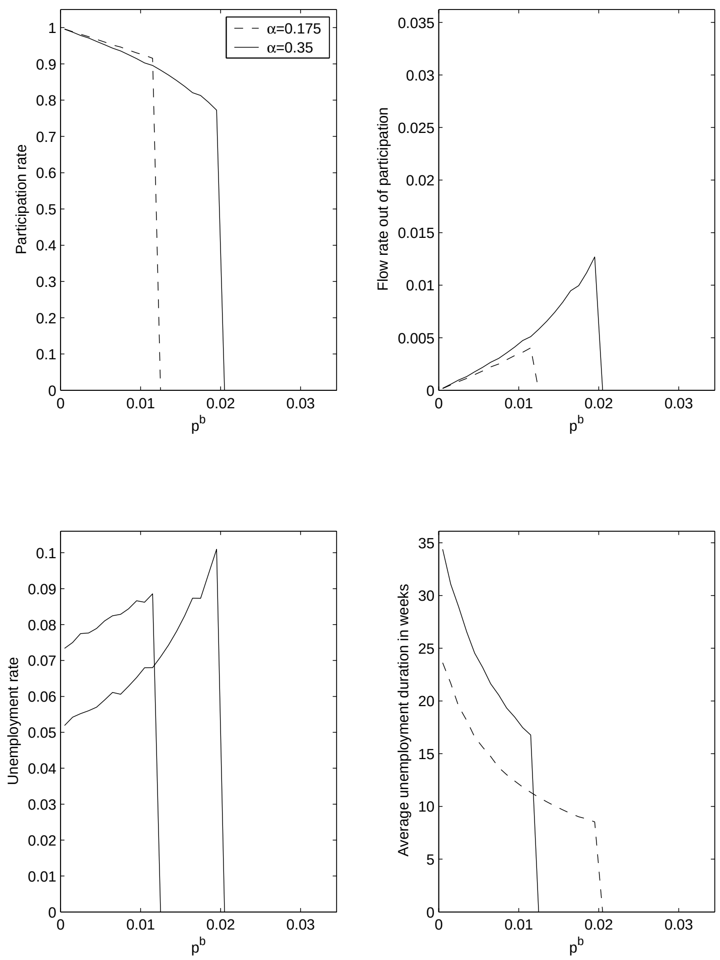


Figure 4: Individual behavior conditional on p^b.

dominates the first. We can get another perspective on the role of these two factors by noting that the fraction of the population that never participates when $\alpha = 0.175$ (i.e., 0.3606) accounts almost entirely for the fraction that at any given point in time is not participating (i.e. 0.3863). For comparison, when $\alpha = 0.35$, among the 0.2455 who are not participating at any given point in time, only 0.1827 are individuals who never participate—the rest are individuals who are temporarily not participating. This demonstrates that for $\alpha = 0.175$ those who participate at least occasionally do so much more consistently.

In addition to the impact on the participation rate, table 4 shows that the increase in frictions also results in approximately a two percentage point increase in the unemployment rate. For given values of p^b, the lower left panel of figure 4 shows that unemployment rates are increasing in search frictions conditional on the value of p^b being such that the individuals participate at least in the good state. There are several countervailing effects that impact the stock of unemployed. Consider first the flows into unemployment. On the one hand, the rate at which workers flow from employment to unemployment is lower when frictions are greater, since some of the employed—those who have high participation costs but are clinging to their jobs—will flow directly to non-participation, and not to unemployment, when an exogenous separation occurs. On the other hand, the rate at which workers flow from non-participation to unemployment is given by p^g and is thus unaffected by the level of frictions. As for the rate at which workers flow out of unemployment, it is reduced by frictions, as seen by the fact, shown in the lower right panel of the figure, that frictions lengthen average unemployment durations. Again, the net result of these various effects is that frictions increase the unemployment rate at all values of p^b for which participation is positive. Of course, the impact on the aggregate unemployment rate depends not only on the unemployment rate for given values of p^b, but also on the composition of participants. As the lower left panel shows, the unemployment rate is increasing in p^b as long as participation is positive, and thus the fact that $\bar{p}^b$ is higher when $\alpha = 0.35$ tends to make unemployment higher when $\alpha = .35$. Nevertheless, this composition effect is clearly outweighed by the increased unemployment rate at lower values of p^b, leading to a higher aggregate unemployment rate when frictions are increased.

It should be noted that the differences between the two columns of table 4 are rather similar to differences that one would observe if comparing the US labor market with various European labor markets. The significance of this should not be overstated–the analysis here is strictly decision theoretic, aggregating decision rules across individuals holding the wage distribution and separation rates constant—a more thorough analysis of cross-country patterns would require a general equilibrium treatment and would force us to identify the cause of the lower job arrival rates in Europe. However, with these qualifications in mind, we find the results suggestive of a quantitatively significant role for the effects captured in the model presented here.

5.4 Sensitivity

Clearly, the substantial decline in the participation rate that results from reducing α from 0.35 to 0.175 is closely related to the assumed distribution of individuals over different values of p^b. Thus, it is worthwhile to examine how sensitive these results are to different parameterizations. As indicated above, the weeks worked distribution played a large role in determining the rate of decay of the distribution over p^b for the baseline parameterization. A sufficiently slow rate of decay was needed in order to produce a mass of individuals above $\bar{p}^b$ that was large enough to match the number of individuals who report zero weeks worked. Specifically, among the 0.2015 of the population that reports zero weeks worked in the model, 0.1827 are the workers who never participate and the other 0.0188 are workers who do occasionally participate but nevertheless experience a whole year without work. It is plausible to suppose that some fraction of those who never participate (and thus report zero weeks worked) in fact do not participate for reasons other than the one emphasized here. For example, some may choose never to participate simply because their payoff from non-participation (z^n) is higher than for other individuals.

To examine this we recalibrate the model under the alternative assumption that 10% of the workforce chooses not to participate for unspecified reasons. This cuts approximately in half the fraction of individuals who report zero weeks worked that must be accounted for by workers with p^b above $\bar{p}^b$. As a result, the rate of decay for the exponential distribution of individuals over values of p^b is higher for this alternative calibration. Of course, as we change this distribution, we also have to change other parameter values in order to still match the various statistics listed in table 3. In fact, a fairly good match of the model to the US data can be achieved by making only two changes (aside from stipulating that 10% of the workforce does not participate for unspecified reasons): increasing by 40% the rate of decay of the exponential distribution over p^b and increasing the exogenous separation rate s from 0.00215 to 0.0023. The results of this second calibration are shown in table 5.

As expected, under this new calibration the decline in the participation rate that results from the increase in frictions is smaller because the higher rate of decay means that there is a smaller mass of workers between two values of $\bar{p}^b$ associated with the $\alpha = 0.35$ and $\alpha = 0.175$ cases. Nevertheless, the decline in the participation rate is still substantial, as are the increases

	U.S.: data	U.S.: model $\alpha = 0.35$	High Frictions $\alpha = 0.175$
Fraction employed	0.7173	0.7126	0.6033
Fraction unemployed	0.0465	0.0482	0.0545
Fraction not participating	0.2362	0.2392	0.3422
Unemployment rate	0.0609	0.0634	0.0827
Ave. search duration (weeks)	15.44	15.61	25.31
0 weeks worked	0.2018	0.2002	0.3360
1-13 weeks worked	0.0451	0.0281	0.0210
14-26 weeks worked	0.0480	0.0462	0.0319
27-39 weeks worked	0.0634	0.0690	0.0457
40-51 weeks worked	0.0831	0.0858	0.0560
52 weeks worked	0.5587	0.5707	0.5094
Monthly e-u hazard rate	0.0113	0.0092	0.0092
Monthly u-e hazard rate	0.2339	0.2702	0.1573
Monthly n-u hazard rate	0.0376	0.0328	0.0119
Monthly u-n hazard rate	0.1443	0.0292	0.0202
Monthly e-n hazard rate	0.0153	0.0114	0.0057
Monthly n-e hazard rate	0.0434	0.0070	0.0013

Table 5: US data and calibrated model, second parameterization

in the unemployment rate and in the average duration of unemployment spells. In other words, the main results are quite robust to the alternative parameterization of the distribution of individuals over p^b.

6 Conclusion

We have introduced and analyzed a worker search model that highlights the interaction between search frictions and the participation decisions of workers with stochastic participation costs. Higher search costs reduce flows into and out of participation. They can also lead to longer unemployment durations, longer employment durations, and higher unemployment rates. These results seem consistent with various observations that result from cross-country labor market comparisons. Countries like the US, with generally fewer labor market regulations and lower search frictions than in many Western European countries, tend to have greater flows into and out of participation, shorter employment and unemployment durations, and lower unemployment rates.

The results of this paper also raise interesting questions about the nature of search equilibrium and the job creation behavior of firms. One would expect that when there is heterogeneity in the expected participation duration of workers, firms would create different types of jobs in order to cater to different types of workers. More specifically, to cater to workers who do not anticipate participating for a long time, firms would have incentives to create low-wage, low-specific human capital jobs that can be quickly obtained. On the other hand, firms would also want to create higher-wage, high-specific capital jobs for workers who anticipate a more protracted employment duration. The model of this paper suggests that these workers would be willing to accept a longer search spell in order to obtain a higher wage. In an equilibrium model that accounts for firms' job creation behavior, a natural question that arises is how different labor market policies—worker dismissal costs, unemployment insurance, minimum wages—affect the mix of jobs that firms choose to create. A natural hypothesis is that such policies discourage firms from creating easy-to-find, low-wage jobs, and consequently reduce the participation of people who desire such jobs. These broader questions that arise in the context of an equilibrium model seem like a promising area for future work.

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