MULTIPLE APPLICATIONS, CONGESTION EFFECTS AND UNEMPLOYMENT

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Resumen

Este artículo estudia una externalidad que opera en los procesos de búsqueda en los que está permitido hacer múltiples postulaciones. Aumentos en el número de postulaciones por individuo disminuyen la probabilidad de que otros trabajadores obtengan buenas ofertas, generando el efecto congestión. Esta externalidad implica que el equilibrio de Nash es sub-óptimo, y está caracterizado por exceso de postulaciones y un salario de reserva demasiado bajo. La implicación macroeconómica de este resultado es una tasa de desempleo sub-óptimamente alta. El artículo provee evidencia de que este efecto de congestión opera en el mercado laboral americano. Usando una encuesta de métodos de búsqueda de trabajo se encuentra que, después de controlar por endogeneidad, un aumento en el número promedio de postulaciones disminuye la efectividad de la búsqueda al nivel individual.

Abstract

This paper studies a congestion effect operating in most search processes in which applicants are allowed to fill multiple applications. Increases in the number of one agent applicant decrease the probability faced by other searchers of a successful match, generating the congestion effect. The presence of this externality causes market equilibrium to be sub optimal. Compared to the cooperative equilibrium, the Nash equilibrium features too many applications per individual, and too low reservation wage. The macroeconomic implications of this suboptimality are, in general, a higher unemployment rate than the one a social planner would have gotten. The paper also provides evidence that this congestion effect operates in the U.S. labor market. Using the Employment Opportunity Pilot Projects household survey, I find after controlling for endogeneity, that an increase in the average number of applications per worker decreases the effectiveness of the individual search.

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1 Introduction

Search models of the labor market seek to explain the unemployment rate as the result of frictions inherently associated to the process of finding jobs and filling vacancies. The resulting natural rate of unemployment can be suboptimal due to externalities in the search process. Information spillovers like in Caplin and Leahy (1994), thick market externalities as in Diamond (1982) and the like are only few of the external effects that may imply that the natural rate of unemployment is too high or too low. Congestion externalities are part of this list. Tobin (1972) says:

> The external effects are the familiar ones of congestion theory. A worker deciding to join a quehue or to stay in one considers the probabilities of getting a job, but not the effects of his decision on the probabilities that other face. He lowers those probabilities for people in the quehue he joins and raises them for persons waiting for the kind of job he vacates or turns down.

Most recently this kind of externality has been discussed by Ball (1991) in the context of labor mobility and Pissarides (1994) in the case of on-the-job search. In both situations workers joining the pool of searchers reduce the exit rate from unemployment for the group they join.

This paper studies a related externality or congestion effect operating in most search processes in which applicants are allowed to fill multiple applications. An increase in the number of applications filled by a searcher reduces the probability of getting job offers faced by other searchers in very much the same manner as an increase in the number of applicants. As usual, the failure to take into account the effect of her actions in others generates the externality.

There is, however, an important difference between increasing the number of applicants and the number of applications. In the later, the proportion between unemployed workers and vacancies, the standard Beveridge curve, is not immediately affected, and therefore it is not obvious that the exit rate from unemployment should be permanently changed. A condition for this to have permanent effects in the exit rate is that it takes time for the firm to select new candidates after an offer rejection left a vacancy empty. One pssibility is that, searchers filling multiple applications hold the offers they receive until they decide which offer they are going to accept. Firms not chosen by workers have to select a new candidate in order to make a new offer. If firms start the selection process all over again after their offers have been rejected, the probability of receiving an offer faced by a searcher will be permanently lowered by an increase in the number of applications. In general, the same permanent result is obtained unless waiting lists move instantaneously. In addition to the potential effect on the exit rate from unemployment, multiple applications have a non trivial effect on welfare through the multiplication of application costs both for workers and firms. Although this paper focuses in the labor market, the congestion effect associated to multiple applications also operates in college and graduate school applications, in rental car and airplane ticket reservations, and in most search activities.

In formal terms, following the seminal work by Stigler (1960) multiple applications are incorporated to the search theoretical literature under the name optimal sample-size search strategies. At the individual level, Benhabib and Bull (1983) and Morgan (1983) integrate the optimal sample-size search strategy with the more standard optimal sequential search strategy. The former analyze the implications of the resulting model for quiting and on-the-job search, while the later looks at the effects of recall in the search strategy. These papers fail to consider, however, the interactions among agents.

The model presented in this paper is one of optimal sample-size and optimal stopping embodied in a model of the labor market with heterogeneous agents and job creation and destruction. The main results arising from the model are the following:

(i) Increases in the number of one agent applications decrease the probability faced by other searchers of a succesful match, generating the congestion effect.

(ii) The presence of this externality causes market equilibrium to be suboptimal. Compared to the cooperative equilibrium, the Nash equilibrium features too many applications per individual, and too low reservation wage. The intuition for this result rests on the equilibrium conditions of the model. On the one hand, Nash players will over-estimate the benefits of an extra application. For a given application cost, they will tend to fill more applications than cooperative players. On the other hand, a larger number of applications implies a lower value of waiting due to the application cost and the congestion effect. In equilibrium, the value of waiting must be equal to the value of accepting an offer, and therefore, the Nash equilibrium reservation wage will be lower than the coopertaive one.

(iii) The macroeconomic implications of this suboptimality are, in general, a higher unemployment rate than the one a social planner would have gotten. This result critically depends upon the distribution function of matches. The lower the variance of this distribution, the larger will be the congestion effect, and the higher will be the resultant unemployment rate.

The second part of the paper provides evidence that the congestion effect not only operates in "winner-take-all markets", but in a much broader scale in the U.S. labor market.[1] Using the Employment Opportunity Pilot Projects household survey, I try to find the effect of multiple applications on the effectiveness of a search process, measured either as the number of offers or the number of acceptances obtained per week by each applicant. I find that, although the effectiveness of the search process of an individual increases as she increases the number of her applications, an increase in the average number of applications per worker around her will actually decrease the effectiveness of her search.

In section 2 I describe the main features of the model and characterize the matching process. In section 3 I solve the model for a symmetric Nash equilibrium and characterize the working of the aggregate economy. Section 4 gives some comparative statics, discusses the welfare implications of the Nash equilibrium, and presents some possible extensions to the basic model. Section 5 provides the empirical evidence, and section 6 concludes.

[1]See Frank and Cook (1996) for a stimulating discussion about the excess competition of searchers for the large rewards offered in sports, entertainment and other activities in the U.S. economy.

2 The Model

2.1 Basic Setup

The economy consists of L workers and K positions. Workers die with probability π each period and are replaced by a new cohort of size πL. L is assumed to be large so that the population is constant. Positions last forever. Time is discrete. There are U unemployed workers and V vacancies. A productive job is created by a successful match between an unemployed worker and an available position. The productive job lasts until the worker dies. Workers observe the quality of the match only after they approach the firm. The productivity of the worker in a firm determines the quality of the match. A successful applicant receives a wage offer proportional to the quality of the match. The ex-ante cumulative probability distribution and probability density functions of wage offers are $F(w)$ and $f(w)$ respectively.

Unemployed workers receive an unemployment subsidy s per period. In each period, they randomly make multiple applications to a given number of available jobs. Each searcher pays a cost c per application filled. Immediately, firms receiving one or more applications make a wage offer to the best applicants.[2] Workers receiving one or more offers decide whether to accept the best offer received.

A key aspect of the model is the matching process. This process determines the rate at which unemployed workers successfully meet vacancies and become employed, and the average quality of those matches. Two decision variables determine the matching process and characterize the solution to the model. First, unemployed workers have to decide how many firms, n_i, they want to contact in a particular period. Secondly, they have to decide which offer if any they want to accept. I show below that the second decision takes the form of a reservation value w_i. A searcher accepts the best offer received when greater than w_i. As ususal, we find n_i, equating the marginal cost and benefit of unilaterally increasing the number of applications.

For analytical simplicity I will look for equilibria in symmetric strategies. In particular, I will consider symmetric Nash equilibria where all agents fill $\bar{n}$ applications

[2] I will discuss later the possibility that firms would make more than one offer per vacancy knowing the probability of rejection they face.

and hold a reservation wage $\bar{w}$.

2.2 The Matching Process

In this section, I develop the main determinants of the number and merit of successful matches after one period of search.

The choice of $\bar{n}$ affects the quantity and quality of offers per worker through three channels. The first one is the probability of receiving at least one offer. In a world of homogeneous agents where the quality of the match is the same for all matches, this probability will completely determine the exit rate and therefore the matching function. In what follows I show that congestion effects enter the model mainly through this variable.

There are two other channels that determine the distribution of the best offer received by the worker. First, firms receiving one or more applications make an offer to the worker with the best match. Since the distribution of the best match (first order statistic) depends on the sample size, the distribution of the quality of the match for actual offers depends on the number of applicants per firm. This number depends on the number of applications per worker. Secondly, workers receiving more than one offer accept the best offer when above the reservation wage. Hence, the distribution of successful matches also depends on the number of offers received per worker, which in turn depends on the number of applications per worker.

2.2.1 The Probability of Receiving an Offer

In any period two sets of agents are making decisions. First, all firms receiving at least one application must chose the best applicant and decide whether they want to make her a job offer. Second, all unemployed workers receiving at least one offer must pick the best one and decide whether they want to accept it and spend the rest of their life working for that firm. For simplicity, I assume that firms always make an offer to the best candidate. In order to understand the working of the matching process in this model, we must know both the probability of a firm getting at least one applicant and the probability of an applicant getting at least one offer.

There are U unemployed workers and V available vacancies. Assume that every unemployed worker fills n applications. The probability of a particular vacancy not receiving an application from a given searcher is $1-n/V$. Assuming independence among the applications of different searchers, the probability of a particular vacancy receiving at least one application after all unemployed workers have applied is

$$\rho(n) = \left[1 - \left(1 - \frac{n}{V}\right)^{U}\right] \tag{1}$$

It is easy to see that for given V and U, this probability increases as the number of applications per searcher increases.

Consider now, the probability of a worker receiving at least one offer. The probability of a worker receiving an offer from a firm she applied, depends on the number of applications already received by that firm. If all the unemployed workers but one apply to n different jobs, the probability of a particular vacancy receiving x applications is given by the binomial probability function

$$\binom{U-1}{x}\left(\frac{n}{V}\right)^{x}\left(1-\frac{n}{V}\right)^{(U-1-x)}$$

Multiplying the last expression by $1/(x+1)$, we get the probability for the last searcher of receiving an offer at that vacancy. If the last worker, in turn, fills n_i applications, the probability of her getting at least one offer is given by

$$1 - \left[1 - \sum_{x=0}^{U-1}\binom{U-1}{x}\left(\frac{n}{V}\right)^{x}\left(1-\frac{n}{V}\right)^{(U-1-x)}\frac{1}{x+1}\right]^{n_i}.$$

Solving the summation, we get

$$p(n_i, n) = 1 - \left[1 - \frac{V}{nU}\left[1 - \left(1 - \frac{n}{V}\right)^{U}\right]\right]^{n_i}. \tag{2}$$

Inspection of this equation indicates that the probability faced by each individual of receiving at least one offer increases with the number of her applications (n_i) and the number of vacancies, and decreases with the number of unemployed workers and, most interestingly, with the number of applications filled by the other workers (n). The last result corresponds to the congestion effect.

To understand the mechanism through which the congestion effect operates, consider the probability of a vacancy to remain empty after one round of searching.

A firm might fail to hire a worker for one of two reasons: it might not get any application, or it might select a worker already chosen by another firm. As we saw, for given U and V, the probability of not getting any application, $[1-\rho(n)]$ decreases as n increases. However, the probability of choosing a worker already committed to another firm increases as n increases. For fixed values of V, U and n_i, the second effect dominates originating the congestion result.

2.2.2 The Distribution of Best Offers

After receiving one or more offers, the unemployed worker must decide whether or not to accept anyone of them. As explained above, workers draw best offers from a distribution generated after two filtering processes are applied to the unconditional distribution of matches.

Firms receiving one or more applications apply the first filter by choosing the applicant with the best match. Workers getting best matches at one or more vacancies apply the second filter by accepting only the best offer received. The more applicants a vacancy gets and the more offers a worker receives, the more effective is the filtering process. For a given number of unemployed workers and vacancies, an increase in the number of applications per worker increases both of the above ratios, and consequently improves the distribution of best offers. Therefore, this mechanism highlights the standard positive effect of multiple applications in the search process as opposed to the congestion effect previously described. In section 4 I discuss the consequences of relaxing the assumption that matches are independently drawn from a fixed distribution. In particular, positive correlation between matches obtained by the same searcher suggests that some workers will monopolize a large number of offers, augmenting the potentiality for congestion effects.

Let $f(\omega)$ and $F(\omega)$ be the density function and the cumulative distribution function, respectively, of the unconditional probability function of the matching parameter. In this section I derive the distribution of best applicants and best offers as functions of n, $f(\omega)$ and $F(\omega)$, through the two step procedure described above.

Consider first the generation of offers by the firms. An offer is made to the best match achieved by a vacancy in a particular period provided the firm got at least one applicant. Therefore, I first need the distribution of the best applicant to a vacancy. The conditional density function for the distribution of the best applicant to a firm, given that the firm received at least one application, is found multiplying the probability that the firm gets l applicants, for $l = 1, \ldots, U$, by the density function of the first order statistic for a sample of size l, and dividing by the probability of getting at least one applicant, $\rho(n)$. Since each one of the U unemployed workers fills n applications and there are V available vacancies, the number of applications received by each vacancy has a binomial distribution function with probability n/V. The first order statistic for a random sample of size l drawn from a density function $f(\omega)$, has the probability function $lf(\omega)[F(\omega)]^{(l-1)}$. Therefore,

$$\phi(\omega; n) = \frac{1}{\rho(n)} \sum_{l=1}^{U} \binom{U}{l} \left(\frac{n}{V}\right)^{l} \left(1 - \frac{n}{V}\right)^{(U-l)} lf(\omega)F(\omega)^{(l-1)}$$

Solving the summation, and rearranging terms I get the density function of the distribution of best applicants as a function of n.

$$\phi(\omega; n) = \frac{f(\omega)}{\rho(n)} \frac{nU}{V} \left[1 - \frac{n}{V}[1 - F(\omega)]\right]^{(U-1)}$$

In turn, the cumulative distribution function is the integral of the density function between $-\infty$ and w. Therefore,

$$\Phi(w; n) = \frac{1}{\rho(n)} \left[1 - \frac{n}{V}[1 - F(\omega)]\right]^{U} \Bigg|_{\omega=-\infty}^{\omega=w}$$

I have assumed that every best applicant to a vacancy gets an offer from that firm. Hence, the distribution of the matches obtained by the best applicants equals the distribution of offers. In turn, the distribution of best offers can be derived from the functions $\phi(\omega; n)$ and $\Phi(\omega; n)$. The procedure is equivalent to the first filter applied above. Consider a searcher filling n_i applications while all others fill n. As before, the density function of the distribution of best offers, provided the searcher received at least one offer, can be constructed multiplying, for $m = 1, \ldots, n_i$, the probability of the worker receiving m offers by the density function of the first order statistic of a sample of size m drawn from the distribution of offers, everything divided by the probability of getting at least one offer, $p(n_i, n)$.

The unconditional probability of being the best applicant to a vacancy, $q(n)$, is given by the probability that the vacancy will receive at least one application, $\rho(n)$, divided by the expected number of applications the vacancy will receive, nU/V. Thus,

$$q(n) = \frac{V}{nU}\left[1 - \left(1 - \frac{n}{V}\right)^{U}\right]$$

The number of offers received by a given unemployed worker filling n_i applications has a binomial probability function with probability $q(n)$. The density function of the distribution of the best offer received by a searcher conditional on receiving m offers is $m\phi(\omega; n)[\Phi(\omega; n)]^{(m-1)}$. Therefore, searchers facing the decision of whether or not to accept the best offer received after filling n_i applications, draw the best offer from a distribution with density function given by

$$\lambda(\omega; n_i, n) = \frac{1}{p(n_i, n)} \sum_{m=1}^{n_i} \binom{n_i}{m} q(n)^m [1 - q(n)]^{(n_i - m)} m\phi(\omega; n)[\Phi(\omega; n)]^{(m-1)}$$

Solving the summation an rearranging, we get

$$\lambda(\omega; n_i, n) = n_i \frac{q(n)}{p(n_i, n)} \phi(\omega; n)\{1 - q(n)[1 - \Phi(\omega; n)]\}^{(n_i - 1)} \tag{3}$$

with cumulative distribution function

$$\Lambda(w; n_i, n) = \frac{1}{p(n_i, n)} \left. \{1 - q(n)[1 - \Phi(\omega; n)]\}^{(n_i - 1)} \right|_{\omega=-\infty}^{\omega=w}$$

2.2.3 Summarizing the Matching Process

Two key probability functions define the matching process in this model: the probability of receiving at least one offer $p(n_i, n)$, and the probability density function from which the best offers are drawn, $\lambda(w; n_i, n)$. Further simplification of these functions can be obtained making the economy arbitrarily large.

Define $\theta = \frac{V}{U}$, substitute θU for V in equations (2) and (3), and let $U \longrightarrow \infty$. We get

$$p(n_i, n) = 1 - \left[1 - \frac{\theta}{n}\left(1 - e^{-\frac{n}{\theta}}\right)\right]^{n_i} \tag{4}$$

and

$$\lambda(w; n_i, n) = \frac{n_i}{p(n_i, n)} f(w) e^{-\frac{n}{\theta}[1 - F(w)]} \left[1 - \frac{\theta}{n}\left(1 - e^{-\frac{n}{\theta}[1 - F(w)]}\right)\right]^{(n_i - 1)} \tag{5}$$

Figure 1.- Probability of Receiving at Least One Offer

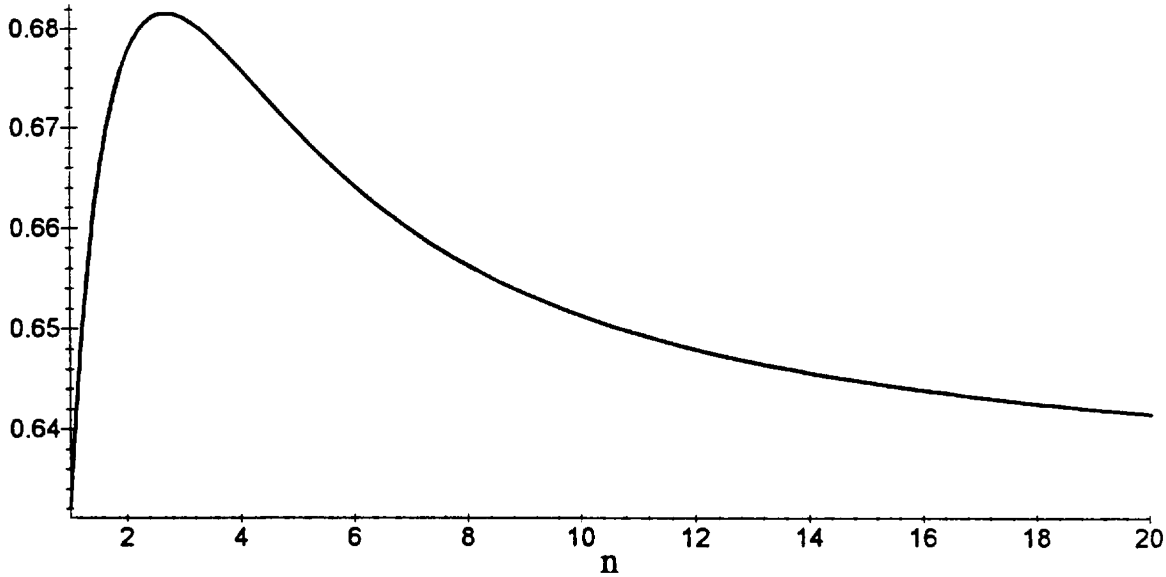
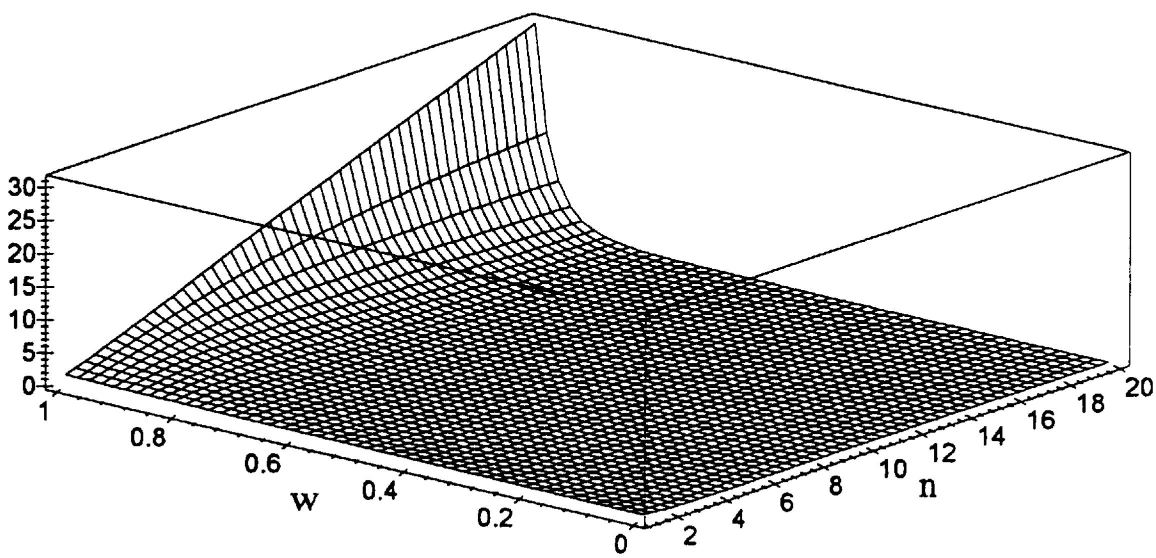


Figure 2.- Probability Density Function of Best Offers



In the next section, I will analyze the solution to the model in terms of a symmetric equilibrium. Hence, in equations (4) and (5), set $n_i = n = \bar{n}$, and consider the case where all unemployed workers increase the number of applications together. The matching process can be summarized now as follows. First, a fraction $p(\bar{n}, \bar{n})$ of all searchers will receive at least one offer out of their $\bar{n}$ applications. Only they will have a chance of becoming employed next period. Second, those workers with at least one offer in hand will decide whether or not to accept the best offer received. This offer constitutes an independently distributed draw from the probability density function $\lambda(w; \bar{n}, \bar{n})$. As we will see, only those workers receiving best offers above the reservation wage will accept and become employed.

How do these probability functions change as we increase the number of applications $\bar{n}$? Figure 1 shows the function $p(\bar{n}, \bar{n})$ for $\theta = 1$. For very low values of $\bar{n}$, the probability faced by each worker of being hired increases with $\bar{n}$ mainly due to the increase in her own applications. However, this probability starts declining as soon as we increase the number of applications above a certain threshold and the congestion effect becomes strong enough.

Figure 2 shows the probability density function of best offers for different values of $\bar{n}$ and for $f(w)$ uniform in the $[0, 1]$ interval. The figure clearly reveals the effect of the filters applied during the matching process. At low values of $\bar{n}$ the density function is flat reflecting the shape of the unconditional distribution of matches. As $\bar{n}$ increases the probability density function of best offers becomes increasingly concentrated towards one, indicating the increase in the probability of getting better offers. This is the standard positive effect of filling a large number of applications.

3 The Solution to the Model

I firstly present the behavior of an individual searcher choosing the reservation wage w and the number of applications n_i, taking as given the number of applications filled by other searchers, n. I, then, characterize the solution to the model in terms of a symmetric Nash equilibrium. Finally, I imbed the individual search strategy into a simple aggregate framework of the economy.

3.1 Nash Strategic Behavior of Workers

An unemployed worker engaged in a search process faces a probability $p(n_i, n)$ of receiving at least one job offer. Upon receiving one or more offers, she must decide whether to accept any of them. Let W be the value of waiting one more period as unemployed worker, and V^e be the value of an optimal search provided that the worker received at least one offer. Then, the unconditional value of an optimal search, J^e, is

$$J^e = p(n_i, n)V^e + [1 - p(n_i, n)]W$$

or rearranging,

$$J^e = W + p(n_i, n)(V^e - W) \tag{6}$$

Now, let $V(w)$ denote the value of an optimal search strategy for an unemployed worker holding a best wage offer w. She can accept the offer and work at this wage for the remaining of her life, or wait and apply to a determined number of jobs next period. Then,

$$V(w) = \max[A(w), W] \tag{7}$$

where $A(w)$ is the value of accepting the offer.

Since each worker that accepts an offer receives the wage w for the rest of her life, the value of accepting is

$$A(w) = \frac{w}{1 - \beta(1 - \pi)} \tag{8}$$

On the other hand, if the worker decides to wait and search again, she collects the unemployment insurance s, pays c per application as a searching cost, and gets the discounted value of the unconditional future optimal search strategy J^e. Therefore,

$$W = s - n_i c + \beta(1 - \pi)J^e \tag{9}$$

Workers optimize their search behavior by choosing the number of applications to make and deciding whether or not to accept the best offer they can get. For a given number of applications n_i, the optimal strategy for a worker is to set a reservation wage $\bar{w}$, and to accept the best offer provided it pays $\bar{w}$ or more. The reservation wage is found, for any given number of applications, by equalizing the value of waiting to the value of accepting. Therefore,

$$\frac{\bar{w}}{1-\beta(1-\pi)} = W \tag{10}$$

A reservation wage policy implies that the unconditional value of an optimal search, provided that the worker received an offer, is W if the draw of w from the distribution of best offers is below $\bar{w}$ and $\frac{w}{1-\beta(1-\pi)}$ otherwise. Since the distribution of best offers is given by $\lambda(w; n_i, n)$, we get

$$V^e = \int_{-\infty}^{\bar{w}} W\lambda(\omega; n_i, n)d\omega + \int_{\bar{w}}^{\infty} \frac{\omega}{1-\beta(1-\pi)}\lambda(\omega; n_i, n)d\omega$$

Rearranging the above equation, we find an expression for the additional benefit of receiving a job offer

$$V^e - W = \frac{1}{1-\beta(1-\pi)} \int_{\bar{w}}^{\infty} (\omega - \bar{w})\lambda(\omega; n_i, n)d\omega \tag{11}$$

Equation (11) simply states that the benefit of receiving an offer is given by the discounted value of the expected payments above the reservation wage.

In addition, for any given value of the reservation wage, the worker must chose the optimal number of applications so as to maximize the value of the search. Substituting equation (9) and (11) in equation (6), rearranging, differentiating with respect to n_i and equating to zero we obtain the first order condition for an optimal search strategy.

$$c = p_1(n_i, n)(V^e - W) + p(n_i, n)\frac{\partial(V^e - W)}{\partial n_i} \tag{12}$$

As expected, the individually optimal number of applications is obtained when the marginal cost of an additional application, c, equals the marginal benefit. The first term on the right hand side of equation (12) is the change on the probability of receiving at least one offer, while the second shows the effect on the distribution of the best offer received, of unilaterally increasing the number of applications.

Consider now the case for symmetric strategies. If $n_i = n = \bar{n}$, equations (6), (9), (10), (11) and (12) provide a system of five equations in the five unknowns $\bar{w}$, $\bar{n}$, W, V^e and J^e. A graphical determination of $\bar{n}$ and $\bar{w}$ can be obtained reducing the system of five equations to two equations in $\bar{n}$ and $\bar{w}$. Define $\gamma(w; n_i, n) =$

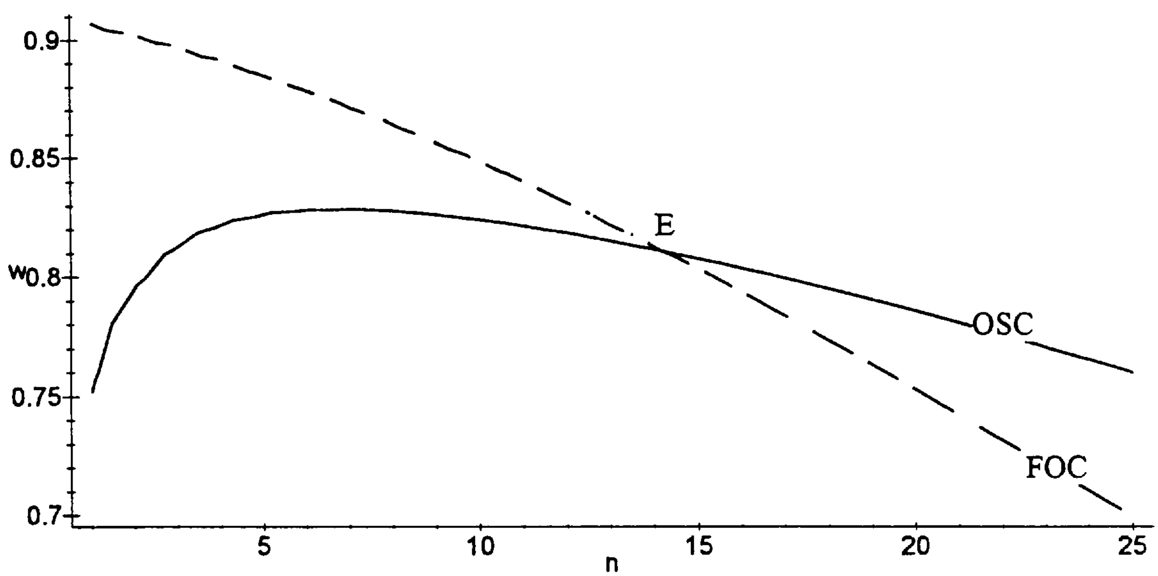
$p(n_i, n)\lambda(w; n_i, n)$ from equation (5). The first equation results from manipulating the optimal stopping condition from equations (10) and (11).

$$\bar{w} = s - \bar{n}c + \frac{\beta(1-\pi)}{1-\beta(1-\pi)} \int_{\bar{w}}^{\infty} (\omega - \bar{w})\gamma(\omega; \bar{n}, \bar{n}) d\omega \tag{13}$$

Rewriting the first order condition in equation (12) using the definition of γ we get

$$c = \frac{1}{1-\beta(1-\pi)} \int_{\bar{w}}^{\infty} (\omega - \bar{w}) \left. \frac{\partial \gamma(\omega; n_i, n)}{\partial n_i} \right|_{n_i, n = \bar{n}} d\omega \tag{14}$$

Figure 3.- Symmetric Nash Equilibrium



An equilibrium to this model exists, provided that equations (13) and (14) intersect at least once. Figure 3 plots the two equations above for $f(\omega)$ the Uniform(0,1) distribution. Equation (14) summarizes the first order condition for maximizing the value of an optimal search through the choice of n_i. The curve consists of all the combinations of $\bar{n}$ and $\bar{w}$ for which the marginal benefit of unilaterally increasing the number of applications equals the cost c, and corresponds to the FOC curve in the figure. The FOC curve is negatively sloped. The intuition for this result is simple. The marginal benefit that a particular worker receives from an additional application decreases as the average number of applications $\bar{n}$ increases. In addition, the benefit of deviating is bigger the lower is the reservation wage $\bar{w}$, because of the increase in the probability of accepting an offer. Therefore, a higher number of applications requires a lower reservation wage for the first order condition to keep holding.

Equation (13) summarizes the optimal stopping condition. It is shown in Figure 3 as the OSC curve. The curve depicts all combinations of $\bar{n}$ and $\bar{w}$ for which the optimal value of accepting equals the optimal value of waiting. The curve slopes up for low values of $\bar{n}$, and down for high values. The positive relationship between $\bar{n}$ and $\bar{w}$ exists because the filtering effect of the application process increases as $\bar{n}$ increases, improving the distribution of best offers. That is,

$$\int_{\bar{w}}^{\infty}(\omega-\bar{w})\frac{\partial\lambda}{\partial\bar{n}}d\omega>0$$

Therefore, a larger $\bar{n}$ increases the value of waiting through a higher expected value of future matches, and consequently it must be compensated by a higher reservation wage that increases the value of accepting today and reduces the value of waiting.

Two other effects working in the opposite direction end up reverting the above relationship. First, increases in $\bar{n}$ decrease the value of waiting by c due to the application cost. Second, for $\bar{n}$ high enough, further increases in $\bar{n}$ decrease the probability of getting an offer due to the congestion effect reducing the value of waiting. Both effects require decreases in the reservation wage to keep the equation holding. Since in addition, the positive effect of increases in the number of applications on the filtering process is decreasing in $\bar{n}$, the positive relationship between $\bar{n}$ and $\bar{w}$ is reverted after we reach a high enough value of $\bar{n}$.

Finally, it is possible to show that the equilibrium is always achieved on the downward sloping segment of the optimal stopping condition curve. A condition for the OSC curve to have a slope equal to zero is

$$c=\frac{\beta(1-\pi)}{1-\beta(1-\pi)}\int_{\bar{w}}^{\infty}(\omega-\bar{w})\frac{\partial\gamma}{\partial\bar{n}}d\omega$$

A little algebra shows that, as expected, the perceived improvement in the distribution of obtained best offers is always greater when workers deviate alone than when they move together. That is

$$\frac{\partial\gamma(\bar{w};\bar{n},\bar{n})}{\partial\bar{n}} < \left.\frac{\partial\gamma(\bar{w};n_i,\bar{n})}{\partial n_i}\right|_{n_i=\bar{n}}, \text{all } \bar{n} \text{ and } \bar{w}.$$

Therefore, if $\bar{w}'$ and $\bar{n}'$ are the values of the reservation wage and applications number for which the OSC curve has slope equal to zero, the reservation wage that keeps the first order condition holding at $\bar{n}'$ must be higher than $\bar{w}'$, and the equilibrium must be obtained at $\bar{n}^* > \bar{n}'$.

3.2 The Aggregate Economy: The Unemployment Rate

The optimal number of applications and the reservation wage obtained at the individual level in the previous section determine, at the aggregate level, the unemployment rate. Assume for simplicity that the number of workers, L, equals the number of positions in the economy, K. Since jobs are either fill or vacant, and workers are either employed or unemployed, we get a very simple aggregate structure with the same number of vacancies and unemployed workers, and $\theta = 1$.

$$\begin{aligned} L &= K \\ L &= E_t + U_t \qquad (15) \\ K &= E_t + V_t \end{aligned}$$

The exit rate from unemployment is determined by the probability of getting at least one offer, given by $p(\bar{n},\bar{n})$, multiplied by the probability of accepting the best offer received, given by $[1 - \Lambda(\bar{w},\bar{n},\bar{n})]$. Therefore,

$$E_{t+1} = p(\bar{n},\bar{n})[1 - \Lambda(\bar{w},\bar{n},\bar{n})]U_t + (1-\pi)E_t$$

Rearrange the equation above considering that in the steady-state $E_{t+1} = E_t$, and rewrite to get an expression for the unemployment rate $u = U/L$,

$$u = \frac{\pi}{p(\bar{n},\bar{n})[1 - \Lambda(\bar{w};\bar{n},\bar{n})] + \pi} \qquad (16)$$

Figures 4.a and 4.b reproduce the exit rate and the unemployment rate, respectively, for different values of $\bar{n}$ and for $\bar{w} = 0.5$. The figures were constructed for

Figure 4.a.- The Exit Rate

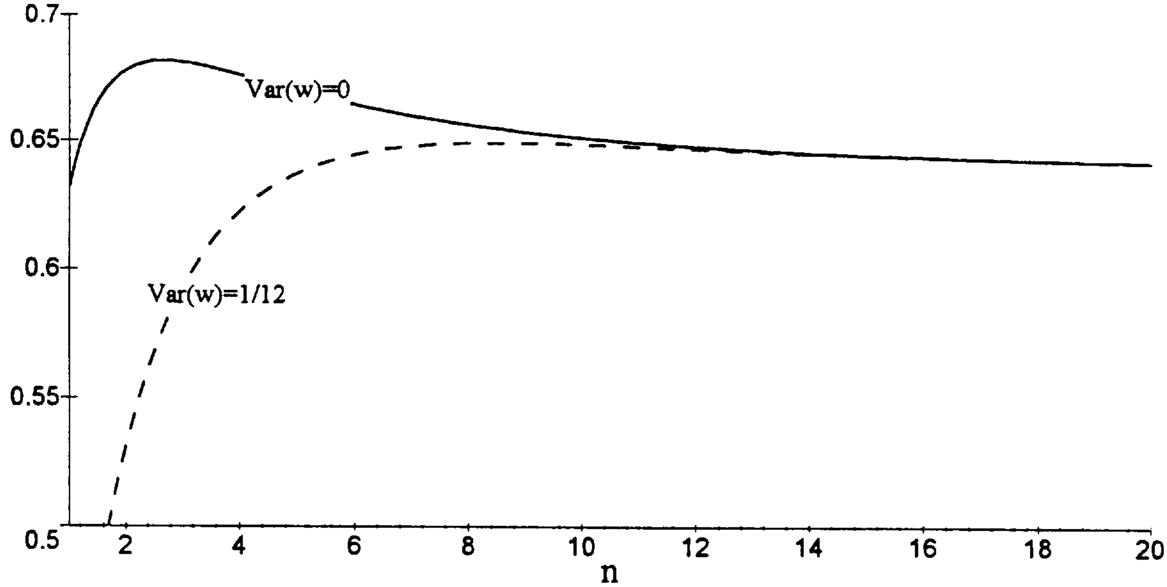
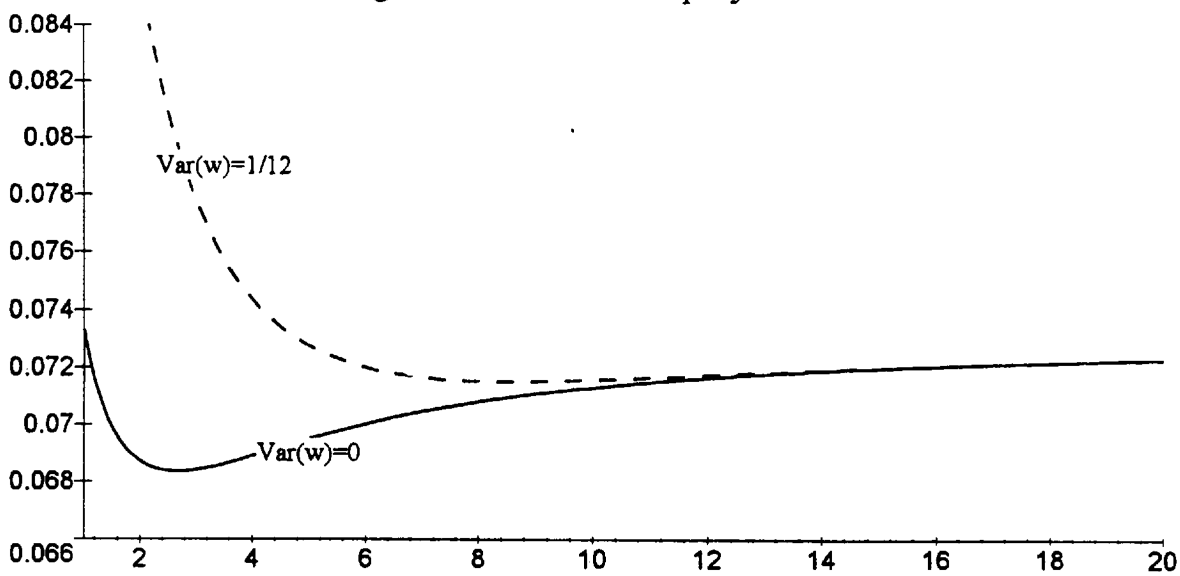


Figure 4.b.- The Unemployment Rate



two different unconditional distributions of w. For the dashed lines I used the $(0,1)$ uniform distribution that has mean 0.5 and variance $1/12$. The continuous lines were drawn under the assumption that the unconditional density function had collapsed to a zero variance-same mean distribution. Such a density function implies that the wage offers have no dispersion, and no positive filtering effect is obtained out of increasing the number of applications. Therefore, the exit rate and the unemployment rate only depend on the probability of getting at least one offer, $p(\bar{n},\bar{n})$, and consequently, the congestion effect is maximum.

It is clear from the figures that we only get non-monotonic exit and unemployment rates (with respect to $\bar{n}$) when the variance of the underlying distribution of matching parameters is very small. A high variance of the unconditional distribution of w implies that the gain obtained from filtering matches overcomes the congestion effect at the aggregate level.

Finally, the average productivity of the working economy is given by the mean of the truncated distribution of best offers above the reservation wage. That is,

$$E(w/w \geq \bar{w}) = \frac{\int_{\bar{w}}^{\infty} \omega\lambda(\omega;\bar{n},\bar{n})d\omega}{1-\Lambda(\bar{w};\bar{n},\bar{n})} \tag{17}$$

4 Analysis of the Model

4.1 Comparative Statics

There are two obvious comparative statics exercises that can be applied to this model. The first one comes from changes in the unemployment subsidy s. The second one arises from variations in the application cost c.

An increase in the amount of the unemployment subsidy s increases the value of waiting in the OSC equation. For a given value of $\bar{n}$ the optimal stopping condition is restored by increasing the reservation wage. A higher value of $\bar{w}$ increases the value of accepting and decreases the value of waiting. Therefore

$$\left.\frac{d\bar{w}}{ds}\right|_{OSC} = \frac{1}{1+\frac{\beta(1-\pi)}{1-\beta(1-\pi)}\int_{\bar{w}}^{\infty}\gamma(\omega;\bar{n},\bar{n})d\omega} > 0.$$

Figure 5.a.- An Increase in the Unemployment Subsidy

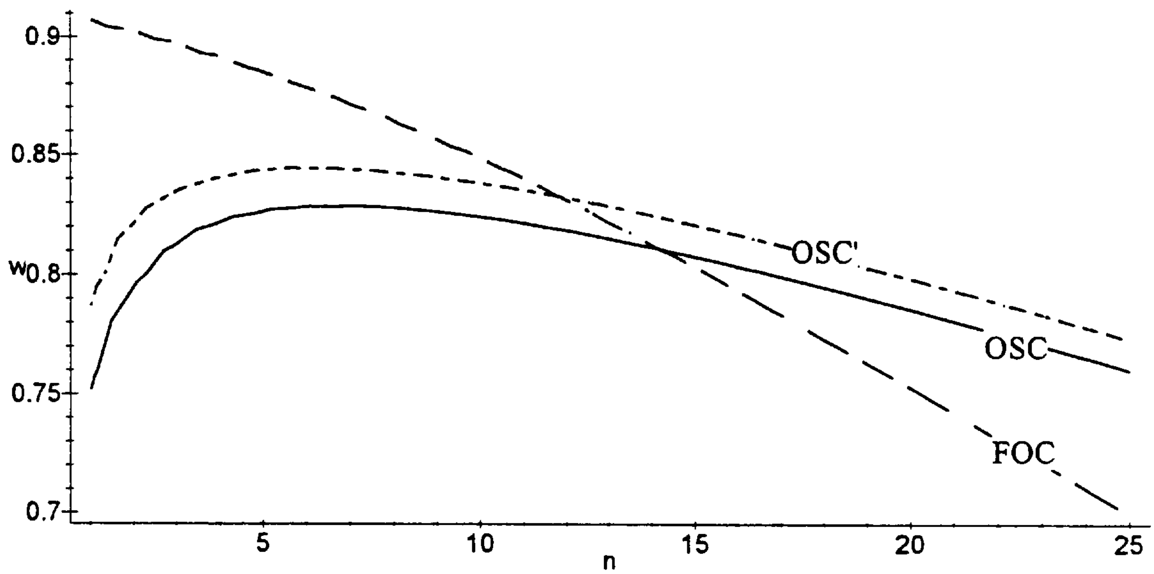
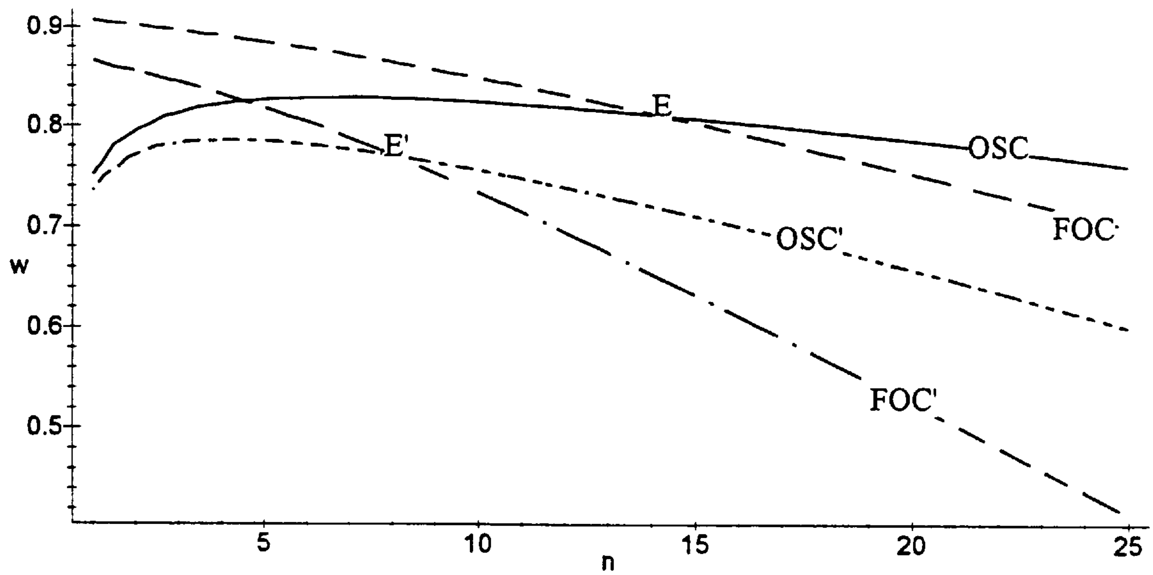


Figure 5.b.- An Increase in the Application Cost



There is no effect of s on the first order condition. Since the FOC curve always slopes down, an increase in the amount of unemployment subsidy unambiguously raises the reservation wage and decreases the optimal number of applications. Figure 5.a illustrates the mechanics of this effect.

Changes in the cost per application affect both the optimal stopping condition and the first order condition. For a given value of $\bar{n}$, an increase in c decreases the value of waiting in the OSC equation and must be compensated by a decrease in the reservation wage that lowers the value of accepting and increases the value of waiting. The negative relationship between c and $\bar{w}$ in the optimal stopping condition is given by

$$\left.\frac{d\bar{w}}{dc}\right|_{OSC} = -\frac{\bar{n}}{1+\frac{\beta(1-\pi)}{1-\beta(1-\pi)}\int_{\bar{w}}^{\infty}\gamma(\omega;\bar{n},\bar{n})d\omega} < 0.$$

Again, for a given value of $\bar{n}$, an increase in c in the first order condition must be compensated by a decrease in the reservation wage. As I explained before, the benefit of unilaterally increasing the number of applications increases with reductions in the reservation wage because of the higher probability of receiving an acceptable offer. We get,

$$\left.\frac{d\bar{w}}{dc}\right|_{FOC} = -\frac{1}{\frac{1}{1-\beta(1-\pi)}\int_{\bar{w}}^{\infty}\left.\frac{\partial\gamma(\omega;n_i,n)}{\partial n_i}\right|_{n_i=n=\bar{n}}d\omega} < 0.$$

The final effect of a higher application cost in $\bar{n}$ and $\bar{w}$ depends on the relative size of the movements of both the OSC and the FOC curve. A little algebra shows that the first order condition is more responsive than the optimal stopping condition to changes in the application cost for any $\bar{n}$,

$$\left|\left.\frac{d\bar{w}}{dc}\right|_{FOC}\right| > \left|\left.\frac{d\bar{w}}{dc}\right|_{OSC}\right|$$

Thus, as expected, an increase in the application cost c unambiguosly decreases the optimal number of applications $\bar{n}$. Figure 5.b illustrates the effect of a change in c from 0.1 to 0.2 for $f(w)$ the Uniform(0,1) distribution. The figure also shows the effect of a larger c on the reservation wage. Although no unambiguous relationship was found between c and $\bar{w}$, all simulations for reasonable values of the parameters of the model indicated that the reservation wage also decreases in response to an increase in c.

Figure 5.c.- A Decrease in the Dispersion of f(w)

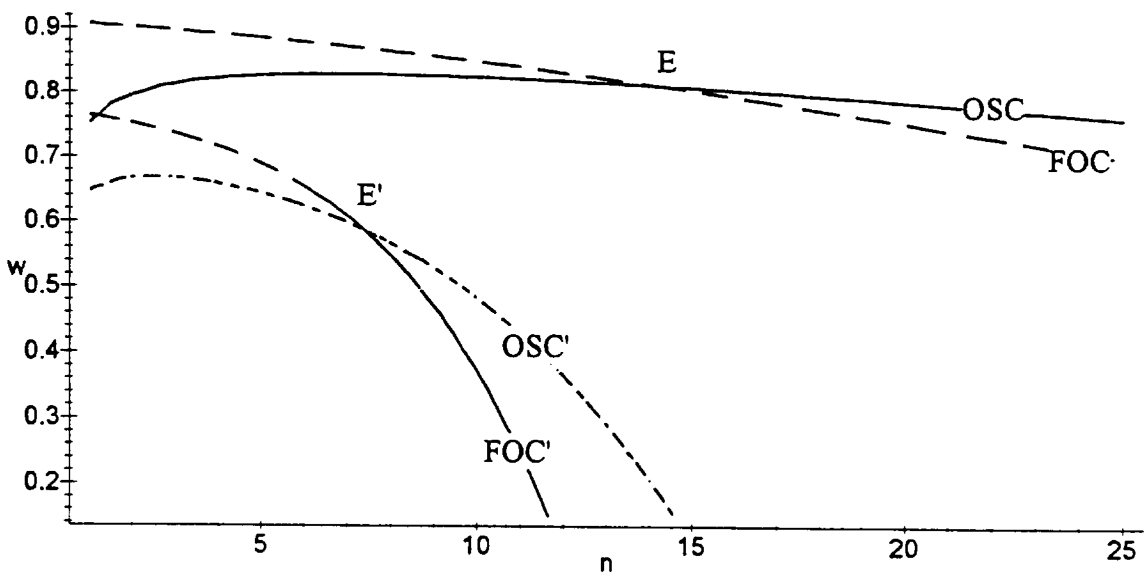


Figure 5.c illustrates a third exercise of comparative statics. For a given mean, a reduction in the variance of the unconditional distribution of the matching parameter reduces the incentives to over apply. This is because of the lower potential gains obtained from filtering bad offers when the unconditional distribution is more concentrated around the mean. Therefore, the effect of a reduction in the variance of $f(w)$ is, as Figure 5.c shows, a reduction in both the number of applications and the reservation wage.

4.2 Welfare Analysis: Cooperative Behavior of Workers

A symmetric Cooperative Equilibrium is obtained by making agents to internalize the externality, maximizing the welfare of a representative agent. We require workers to maximize the value of an optimal search in equation (6) considering the effect of the change in the number of applications by the other agents. The first order condition in equation (14) must reflect this.

$$c = \frac{1}{1-\beta(1-\pi)} \int_{\bar{w}}^{\infty} (\omega - \bar{w}) \frac{\partial \gamma(\omega; \bar{n}, \bar{n})}{\partial \bar{n}} d\omega \tag{18}$$

Figure 6.- Cooperative Equilibrium

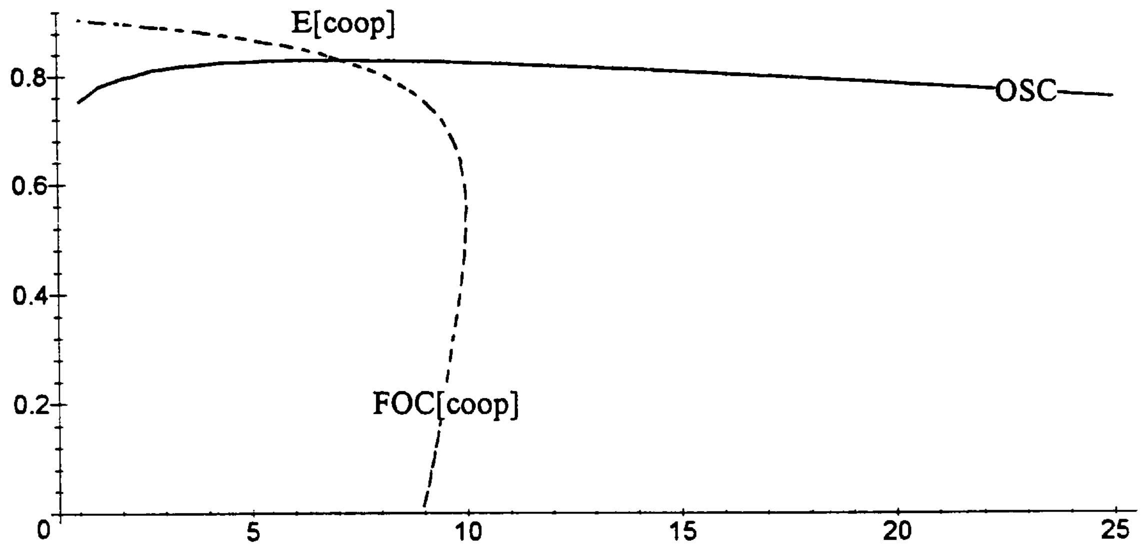


Figure 6 presents the optimal stopping condition curve, plus the new condition for a Cooperative equilibrium from equation (20). Notice, that the Cooperative equilibrium is also achieved at the downward slopping part of the optimal stopping condition, but at a much lower value for the number of applications. The Cooperative equilibrium first order condition curve is always to the left of the Nash equilibrium first order condition because, as it was shown above, the perceived improvement in the distribution of obtained best offers is always greater when workers deviate alone than when they move together. Hence, the Cooperative equilibrium will always be characterized by a lower number of applications and a higher reservation wage than the corresponding Nash equilibrium.

4.3 Extensions to the Basic Model

There is a long list of possible extensions to the model presented in this paper. All of them would add realism and analytical complexity to this model. I briefly discuss some of the extensions most related to the congestion effect.

A first consideration regarding matching processes is the existence of differences across individuals. I have assumed in this model that all searchers draw independent matching parameters from the same underlying distribution. But, one could easily conceive a model in which individuals make independently distributed draws from indexed distributions $f_i(w)$. If some distributions first-order stochastically dominate other distributions, so there are permanent differences in skills across searchers, then one could expect that some workers will concentrate a large number of offers agravating the congestion effect.

A similar outcome could be achieved if searchers make non-independent draws from the same distribution.[3] In such circumnstances when sometimes, some people do thinghs better than others, there will also be bunching of offers in some searchers' hands.

The congestion effect affects the ability of firms to rapidly fill a vacancy. There are several ways in which firms might try to overcome this problem. One way is allowing firms to make more than one offer per vacancy. If firms approximately know the proportion of workers that reject their offers, they could simply make the number of offers that in average gives them one acceptance. Of course, the cost associated with having two or more workers for each vacancy is not trivial, so firms might prefer to get short in average, and the congestion effect would still persist.

A related way for firms to overcome the problem of workers over-rejecting their offers is by simply moving down on the waiting list. This is, in fact what it seems

[3]Consider, for simplicity, the simplest case when, in every period, all n_i matching parameters are revealed to the searcher simultaneously.

to happen in the selection process for occupations requiring low skilled workers. The faster is the process of calling the next candidate the less important should be the congestion effect.

5 Empirical Evidence

The purpose of this section is to provide evidence about the existence of the congestion effect in the observed search patterns of employed and unemployed workers in the U.S..

5.1 The Data

I use data from the Employment Opportunity Pilot Projects (EOPP) household baseline data base. The data were originally collected to measure the impact of an intensive job search program combined with a work training program. The program began to be applied in the summer of 1979, and was phased out during 1981. The program was designed to try to place program participants in private sector jobs during an intensive job search assistance program. The participants were assigned to a federally-assisted job or to training positions, whenever no private sector job was found.

The household baseline survey was conducted between February and December 1980. It covered 10 pilot sites and 10 matching control sites in geographically dispersed areas throughout the U.S.. A total of 29,620 families and 53,882 adult individuals were interviewed.[4] The survey collected measures of earnings, employment and unemployment spells, search methods, and a list of demographic characteristics and other variables.

[4]Because the program was designed to assist low-income individuals, the survey contains an oversample of low- and middle-income families with children. However, high-income and without children families were also interviewed during the survey so there is no problem of sample truncation.

5.2 Search Intensity Patterns

The EOPP survey provides several meassures of search intensity. Individuals interviewed were asked to identify their two most recent job search spells, and to provide information about the duration of the spells and the number of contacts and applications made through a variety of search methods during those periods. The survey also took record of the number of offers received by each searcher and whether she or he accepted any of them. In addition, individuals sampled were classified according to their three digit occupation codes.

In order to study the presence of congestion effects in the job search process, I considered four different occupational groups: First, individuals applying to occupations requiring formal education like lawyers and architects. Second, individuals applying to any kind of supervisor position. Third, salesmen and all clerical positions not requiring specific skills. Fourth and finally, mechanical and production working occupations with some degree of specialization.[5]

Table 1 summarizes the search patterns of the different occupation groups. In average, searchers contact more than three firms and fill two applications each week, and end up getting one offer out of every 5.88 applications. These figures substantially vary across occupation groups. While searchers in occupations requiring formal education only fill 1.38 applications per week, workers in clerical occupations fill almost twice that number, 2.14 applications each week. On the other hand, the most skilled workers receive, in average, one job offer out of every three applications, while clercks get only one offer for every 6.5 applications.

Differences in the search patterns of different occupation groups reflect the specific characteristics of the matching process for each group.[6] The selection of an appropiate candidate in high skilled occupations is more involved in terms of the time and the information required to produce an adequate profile of the worker. Hence, higher application costs may explain the lower application rate of high skilled

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[5]The exact subdivision by occupational group is presented in the appendix at the end of the paper.

[6]Informal evidence on some of the observations made below was obtained through conversations with managers of private employment agencies.

workers. Searchers in those occupations apply to a lower proportion of the firms they initially contact and receive more offers per application filled than workers in low skilled occupations. This behavior is consistent with workers in occupations requiring formal education applying only to firms in which the probability of a succesful match is higher, in order to reduce the application costs incurred.

The evidence provided in Table 1 also shows that skilled searchers only accept, in average, one out of every 3.5 offers received. In contrast, production workers accept one out of every 1.6 offers received. This difference might be explained by the higher disperssion of job matches in the market for skilled workers. Production workers would expect most job offers received to be alike and therefore they find little incentives to wait for a better offer.

5.3 Evidence on the Congestion Effect

In this section I present the main evidence on the existence of the congestion effect in the job search process. The structure of the test proposed is fairly simple. I define a set of reference cells through the interserction of 39 different occupation categories and 20 different geographic locations. Employed and unemployed searchers belonging to the same cell are assumed to be applying to the same available positions.[7] Under this assumption, congestion effects would imply that, ceteris paribus, an increase in the average search intensity in the cell would reduce the effectiveness of the search effort at the individual level.

I use two measures of search effectiveness. First I take the number of offers per week received by each applicant as an approximation to the function $p(n_i, n)$. Secondly, I use the number of acceptances per worker per week as an approximation to a reduced form of the exit rate $p(n_i, n)[1 - \Lambda(w_i; n_i, n)]$. I, then, regress each one of the two measures against the individual and average search intensity, together with a set of control variables. Search intensity or effort is measured by the number of applications per week filled by each searcher. The average of this variable over the rest

[7] Although the search spells do not necessarily cover the same period of time for every individual in the sample, all search spells must have happened during the previous year to the year the survey was carried out.

Table 1

Search Intensity Patterns:
Average Weekly Number of
Contacts, Applications, Offers and Acceptances by Occupation Group

Occupation Group				
All Occupations	Occupations Requiring Formal Education	Supervisors	Sales, Clerical and Service Occupations	Mechanics and Product. Working Occupations
Contacts per week				
3.23	2.85	3.43	3.46	3.04
(11.00)	(6.40)	(9.08)	(14.40)	(7.42)
Applications per week				
1.90	1.38	1.91	2.14	1.80
(5.29)	(2.82)	(5.84)	(5.83)	(5.13)
Offers per week				
0.32	0.46	0.31	0.33	0.25
(0.79)	(1.22)	(0.57)	(0.80)	(0.60)
Acceptances per week				
0.15	0.13	0.12	0.17	0.15
(0.34)	(0.26)	(0.26)	(0.36)	(0.35)

Standard deviations are in parentheses

of each cell gives a measure of the search intensity displayed by the reference group of each worker. The control variables define a set of demographic, race, education and working status characteristics of each individual.

The model presented in this paper predicts that increases in the number of applications filled by the reference group of an individual will decrease, ceteris paribus, the effectivenes of her own search effort. Hence, a negative and significant coefficient for the average number of applications filled by the reference group should be interpreted as evidence supporting the existence of congestion effects in the labor market.

There is, however, one caveat to this specification in the presence of differences in the tightness of the labor market accross cells. In those cells where the number of searchers is high relative to the number of vacancies, the market will be tighter and we could expect searchers facing more difficulties in order to find a new job. It is also likely that in those cells, searchers will display a higher level of search intensity to overcome the tighteness of the market. To make this point clear consider the following specification of the equation I want to estimate.

$$efect._{ij} = f(intens._{ij}; \overline{intens._j}; controls_{ij}) + \eta_i + \epsilon_j \tag{19}$$

The simultaneous determination of both search intensity and search effectiveness implies a negative correlation between the error term, ϵ_j, and the two measures of search intensity in the right hand side of the equation. When the labor market in cell j is tighter, ϵ_j will be smaller and the search intensity displayed in the cell will be higher. Unless controlled for, this effect will tend to bias the coefficients on the search intensity variables towards being negative.

In order to control for this effect I make the following identifying assumption. Suppose that market conditions in each cell are due to location specific effects and/or occupation specific effects. That is, the job-market in a cell might be depressed either because that location is in bad shape or because the demand for that particular occupation is low at the national level. Then,

$$\epsilon_j = v_{loc.} + \omega_{occ.} \tag{20}$$

Under this identifying assumption, the simultaneity problem is controlled for, simply by including in the estimation of equation (19) two sets of dummy variables. The first set controls for location specific effects and the second controls for occupation specific effects.

Table 2.a presents the results for the regressions by occupation group when I use the weekly number of offers received by each searcher as the dependent variable. Since this variable is censored at zero, the regressions were estimated using a single-limit Tobit model under the Normal assumption in order to eliminate the omitted-variable bias. Regarding the control variables, the table shows that, ceteris paribus,

men receive significantly fewer offers than women, except for occupations requiring high education levels. Blacks and spanish people receive fewer offers than whites, and younger people receive more offers than older people, in all occupation groups. More years of education increase the number of offers received. Finally, employed searchers receive more offers than unemployed searchers, for a given number of applications, and searchers receiving welfare get fewer offers. Most of these results are not surprising and are consistent with Blau and Robins (1990).

Search intensity affects the number of offers received as predicted by the model. An additional application filled by a searcher increases the number of offers she receives, for a given number of applications by her reference group.[8] An increase in the average search intensity displayed by the reference group reduces the effectiveness of the search at the individual level (congestion effect) for all groups but the clerical occupations.[9]

Table 2.b presents the same type of regressions for the acceptance rate. The number of acceptances per week of search spell can be seen as an approximation to the exit rate from unemployment. This rate depends both on the probability of receiving an offer and on the probability that the best offer received is better than the reservation wage. This second component of the exit rate reduces the resulting congestion effect through the previously discussed filtering process, specially in those occupation groups that exhibit a high variance of the matching parameter. Hence, the average search intensity displayed by the reference group should have a lower effect on the individual search effectiveness. Table 2.b shows that, in fact, the congestion coefficient is negative but no longer significant for the most skilled occupations.

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[8]The actual marginal effect $\frac{\partial E[y_i/x_i]}{\partial x_i}$ can be found, in the censored regression model, scaling the coefficients by the probability in the uncensored region.

[9]The failure to find the congestion effect among salesmen and clercks might be related to the simplicity of the selection process for that group. A condition for the congestion effect to appear is that it takes some time for the firm to replace a candidate that refuses an offer. Apparently, waiting lists only move fairly quickly in low skilled clerical occupations. Instead, managers of private employer agencies find that in occupations requiring more skills or formal education, firms start the selection process all over again after a chosen candidate refuses an offer.

Table 2.a

Reduced Form Estimates of
Offers per Week of Search Spell by Occupation Group
Single-Limit Tobit Regressions

Variable	All Occupations (1)	Occupations Requiring Formal Education (2)	Supervisors (3)	Sales, Clerical and Service Occupations (4)	Mechanics and Product. Working Occupations (5)
Intercept	-0.357*	-0.187	0.181	-0.598*	-0.227
	(0.124)	(0.485)	(0.328)	(0.202)	(0.164)
Number of applic.	0.071*	0.283*	0.075*	0.060*	0.060*
	(0.001)	(0.016)	(0.012)	(0.002)	(0.001)
Avg. num. of applic.	-0.024*	-0.072*	-0.061*	0.027‡	-0.029†
	(0.007)	(0.034)	(0.014)	(0.016)	(0.013)
1 = Male	-0.129*	0.019	-0.094	-0.139*	-0.137*
	(0.034)	(0.104)	(0.084)	(0.048)	(0.051)
1 = Black	-0.309*	-0.572*	-0.222†	-0.352*	-0.148*
	(0.041)	(0.171)	(0.110)	(0.058)	(0.057)
1 = Spanish	-0.104†	0.297	-0.057	-0.195†	-0.095
	(0.051)	(0.257)	(0.137)	(0.083)	(0.068)
1 = Married	-0.010	-0.002	-0.213†	-0.019	0.031
	(0.033)	(0.116)	(0.096)	(0.048)	(0.048)
Years of age	-0.009*	-0.017‡	-0.014	-0.008‡	-0.008‡
	(0.003)	(0.010)	(0.009)	(0.004)	(0.004)
Years of educ.	0.020*	0.011	0.024‡	0.027*	0.016†
	(0.006)	(0.021)	(0.014)	(0.009)	(0.007)
1 = Curr. working	0.404*	0.498*	0.333*	0.412*	0.323*
	(0.029)	(0.121)	(0.078)	(0.043)	(0.038)
1 = Rec. unemp. ins.	-0.182*	-0.251†	-0.194*	-0.181*	-0.166*
	(0.031)	(0.121)	(0.075)	(0.054)	(0.037)
Years of work exp.	0.004	0.008	0.004	0.002	0.006
	(0.003)	(0.011)	(0.009)	(0.005)	(0.005)
No. of observ.	6,344	745	453	2,739	2,407
Log likelihood	-6,964	-966	-378	-3,063	-2,238

Standard errors are in parentheses
* Significant at the 1 percent level; † Significant at the 5 percent level; ‡ Significant at the 10 percent level

Table 2.b

Reduced Form Estimates of
Acceptances per Week of Search Spell by Occupation Group
Single-Limit Tobit Regressions

Variable	All Occupations (1)	Occupations Requiring Formal Education (2)	Supervisors (3)	Sales, Clerical and Service Occupations (4)	Mechanics and Product. Working Occupations (5)
Intercept	0.231*	0.049	0.097	0.299†	0.195‡
	(0.069)	(0.179)	(0.235)	(0.121)	(0.108)
Number of applic.	0.029*	0.041*	0.054*	0.021*	0.046*
	(0.001)	(0.006)	(0.001)	(0.002)	(0.002)
Avg. num. of applic.	-0.012*	-0.017	-0.050*	0.014	-0.016‡
	(0.004)	(0.013)	(0.012)	(0.010)	(0.009)
1 = Male	-0.055*	-0.051	-0.056	-0.048‡	-0.067†
	(0.018)	(0.038)	(0.061)	(0.029)	(0.033)
1 = Black	-0.122*	-0.123†	-0.181†	-0.110*	-0.097*
	(0.024)	(0.061)	(0.087)	(0.037)	(0.038)
1 = Spanish	-0.047	0.090	-0.209‡	-0.105†	0.018
	(0.029)	(0.091)	(0.114)	(0.048)	(0.043)
1 = Married	0.015	0.049	-0.027	0.006	0.044
	(0.018)	(0.041)	(0.072)	(0.028)	(0.031)
Years of age	-0.003‡	-0.004	-0.004	-0.003	-0.001
	(0.002)	(0.004)	(0.007)	(0.002)	(0.003)
Years of educ.	-0.001	0.007	0.021†	-0.004	-0.002
	(0.003)	(0.008)	(0.010)	(0.006)	(0.005)
1 = Curr. working	0.063*	0.032	0.126†	0.079*	0.044‡
	(0.017)	(0.048)	(0.062)	(0.027)	(0.026)
1 = Rec. unemp. ins.	-0.062*	-0.009	-0.164*	-0.077†	-0.043†
	(0.018)	(0.044)	(0.056)	(0.033)	(0.024)
Years of work exp.	0.001	-0.001	0.005	0.000	0.001
	(0.002)	(0.004)	(0.008)	(0.003)	(0.003)
No. of observ.	3,987	553	302	1,762	1,370
Log likelihood	-2,516	-253	-158	-1,230	-757

Standard errors are in parentheses
* Significant at the 1 percent level; † Significant at the 5 percent level; ‡ Significant at the 10 percent level

6 Conclusions

This paper presented a search model of the labor market in which searchers are allowed to fill multiple applications. The model is embeded in a standard sequential search model so workers choose a reservation wage and an optimal number of applications in every period of search. The model features the presence of an externality or congestion effect. An increase in the number of applications filled by a worker reduces the probability of receiving a job offer faced by the other searchers. This externality is responsible in turn for the Nash equilibrium featuring too many applications.

An increase in the average number of applications improves the ex-post distribution of best offers, thus partially offseting the effect of the congestion externality in the exit rate from unemployment. In general, the congestion effect will only dominate, reducing the average exit rate, when the ex-ante distribution of matching parameters is very concentrated.

The paper provides evidence of this congestion effect for the labor market in the U.S.. For most occupation groups, an increase in the average number of applications filled by the reference group of an individual, will decrease his or her search effectiveness measured as the number of offers and acceptances per week.

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