Abstract

In this paper I review the literature of directed search with particular focus put on the worker and her application strategies. While theoretical models do reasonably well in describing certain findings, there are some empirical results that are revealing about how workers search for jobs that do not directly fall out from these structural environments. Here, I explore the foundational theory underlying the behavior of workers searching for jobs and I examine the empirical evidence for, and additional findings about, this behavior. Moreover, I propose an interesting extension for this literature that incorporates a relatively new area of research, networks, motivated by an observation that cannot be reconciled by the available models.

1 Introduction

Models of search are tools that can help capture market frictions that are typically ignored by simple neoclassical frameworks. In a labor market setting these frictions can help explain why
we observe unemployed workers and unfilled vacancies simultaneously or why some people
decline job offers, to give some examples. While basic search models can give some insights
into these phenomena, directed search models have emerged as important frameworks that
can account for these and other stylized facts by enabling agents to distinguish between firms
ex ante. The present paper reviews the literature of directed search with particular focus on
the worker and her application strategies.

Before getting started, it is useful to situate the topic studied here amongst the broader
search and assignment literatures. Directed search broadly refers to a situation where workers
or firms can target (in some fashion) the other for the purposes of finding a job or filling
a vacancy. One of the first formal worker-directed search models can be traced back to
Salop (1973)’s paper on systematic job search. Here, workers must choose an ordering of
firms to apply to and their cutoff (reservation wage) strategy for each firm in this ordering.
Though this model makes (and fits) some important empirical predictions, it is limited in
its treatment of firms.

Assuredly, properly modeling firms and their behaviors is key to better understanding
more of the empirical observations we see in the data. For instance, why do certain types of
workers find employment at certain types of firms? Or, why do otherwise similar workers earn
different wages at different firms? These questions are closely associated with the assignment
literature—that is, the body of research concerned about the distribution of workers across
firms. It is only with a thorough construction of both sides of the labor market that we can
say anything of significance about these observations.

What turns out to be vital in generating this assortative matching (and some other
results) alluded to above is wage determination. There are two main methods of modeling
this aspect of worker-firm interaction that have gained a lot of traction (at least theoretically): bargaining and wage posting. Because I focus on directed search by workers, the latter approach will turn out to be the natural structure of choice in these models (of course, individuals might sort on some other job characteristic). The pairing of directed search and wage posting elements is referred to as competitive search, and will provide an important backdrop for the material studied here. In these models market frictions manifest through a coordination problem: multiple workers may apply for the same job and some vacancies might get zero applications.

Taking a brief step back, in this paper I will explore the theoretical underpinnings of, and empirical evidence for, models of worker-directed search. In this effort I aim to synthesize knowledge about this framework to clearly identify strengths and weaknesses of each formulation, and to identify fruitful areas with which to expand and extend the literature. The rest of this paper is organized as follows. In section 2 I explore one of the more simple environments, systematic job search. Section 3 looks more closely at a more recent theoretical structure, competitive search models, which provides less limited predictions about worker application behavior. After, before concluding, I provide some thoughts as to what I feel are promising extensions of the work studied here. To this end I hope to help bridge the disconnect between theory and empirics, the former of which might be poised to gain from a richer understanding of worker behavior made possible by advances in big data availability (for example, from job boards).
2 Systematic Job Search

One of the first formal search models that incorporated worker choice of which firms to apply to dates back to Salop (1973) and his work on systematic job search. Previously, models had assumed that individuals sampled from operating firms randomly (Lippman and McCall, 1976). This is not realistic. Workers generally know certain things about hiring firms, like which firms be a good or bad “fit,” and choose who (and in which order) to apply to. From a welfare standpoint, by allowing workers reign to direct their search to “better” firms first, they are strictly better off than when they were left to aimlessly bump into firms. To get a better understanding of the origins of the overall subject studied here (and to provide a contrast to later work), the seminal model is briefly laid out below.

2.1 Theory

The standard model is relatively simple. Agents direct their search to firms in a sequential order without the ability to reapply and do not update their subjective knowledge of the wage density function \( f^j(w) \) faced at each firm \( j = 1, \ldots, J \) as their search period continues. Workers can sample once each period and face a take it or leave it offer which is decided upon using a reservation wage strategy. With their subjective knowledge about a firm’s wage offerings, workers have a subjective probability that a firm in period \( t \) offers a wage at least as high as the reservation cutoff, \( y^j_t \), given by

\[
\alpha^j_t \equiv Pr(w^j_t \geq y^j_t) = \int_{y^j_t}^{\infty} f^j(w) dw. \tag{1}
\]
Given this, we can write the expected wage at firm \( j \) in period \( t \) conditional on being offered an acceptable one:

\[
h_{ij}^t \equiv \mathbb{E}[w_{ij}^t | w_{ij}^t \geq y_{ij}^t] = \frac{1}{\alpha_i} \int_{y_{ij}^t}^{\infty} w f_{ij}^t(w) dw.
\]  

(2)

Assuming that the wage distributions are stationary over time and workers have a rate of time preference given by \( \rho \), the worker’s problem is to choose an ordering of firms \( \phi \) and the associated cutoff levels \( \{y_t\} \) that maximizes the present discounted value of expected wealth:\(^1\)

\[
\mathbb{E}[W] = \frac{1 + \rho}{\rho} \left[ \alpha_1 h_1 + \frac{1 - \alpha_1}{(1 + \rho)} \alpha_2 h_2 + \cdots + \frac{\prod_{t=1}^{N-1} (1 - \alpha_i)}{(1 + \rho)^{N-1}} \alpha_N h_N \right].
\]  

(3)

Procedurally, we can think of agents as choosing optimal cutoff sequences for every possible ordering (which is finite) and picking the combination that yields the highest value of (3). That is, for all possible \( \phi \), \( \mathbb{E}[W] \) is calculated and then the agent chooses the ordering that generates the highest expected wealth.

There are two important results that emerge from the above optimization problem. First, firm \( a \) is applied to before firm \( b \) if

\[
\frac{\alpha^a h^a}{\rho + \alpha^a} \geq \frac{\alpha^b h^b}{\rho + \alpha^b}.
\]  

(4)

That is, it samples the firm with the better discounted expected wage outlooks. Second, the optimal reservation wage sequence \( \{y_t\} \) is such that \( y_t \geq y_{t+1} \). In words, workers get less choosy as their searching period continues. The intuition is that, given a limited working

\(^1\)Note that the superscript notation is suppressed because, by construction, the first firm is applied to in the first period.
horizon, agents lower their asking wage the longer they are unemployed because they have less future wage earning opportunities. That agents sequentially target firms and lower their standards as their unemployment spell lengthens provides some testable predictions, which I turn to next.

2.2 Evidence

What makes the above framework particularly appealing for the purposes of going to the data is that the structure of the model is not very restrictive on workers’ beliefs. Indeed, each agent is allowed “subjective beliefs” over their employment prospects at each firm. Thus we won’t have to impose any restrictions on how applicants sort and apply to firms. At the same time, however, such a framework is not rich enough to account for the many factors that feed into these beliefs and, as a result, offers limited predictive power with regard to how they order their search. Moving forward, I first look to evidence for the declining cutoff of acceptable wages over an unemployment spell.

Kasper (1967) is one of the first papers that documents this situation. Using data from a random sample of questionnaires submitted by the Minnesota Department of Employment Security between April and September 1961, he runs a very simple regression of the relative difference of the wage earned at one’s last job and her present asking wage on a constant and the duration of unemployment. The results indicate that the asking wage declines by 3% per additional month of unemployment. Though this fits our intuition, this result is far from convincing as the data were relatively low frequency and the sample lasted only 6 months (6 observations per person). The next paper I look at, though, provides some more powerful
Krueger and Mueller (2014) gather their own data in a survey of 6,025 unemployed workers over a 24 week period in New Jersey from late 2009 to early 2010. Because the unemployment rate of New Jersey was very stable over this period, the authors argue that this sample avoids some of the issues that might have been concern in Kasper (1967). To start, descriptive analysis of this rich data provide some interesting statistics. In the first few months of unemployment (around 15 to 19 weeks), the reported reservation wages of workers were higher than the wage held at their most recent job. Beginning in the fifth month, however, the asking wage begins declining and declines faster for those coming from full-time jobs.

Next, Krueger and Mueller (2014) use a fixed effects specification with a set of controls and find that those with more savings and those who are older (above 50) reduce their reservation wage by more than their counterparts as unemployment continues. Regarding the savings result, it makes sense that the reservation wage was more sensitive (relative to the last job’s wage) for those with relatively high amount of savings. For those without much savings, for instance, we would expect the reservation wage to be low and remain relatively stable (and low) over the course of the searching period. For older workers, who have limited opportunities to wait for the “right” match, the greater relative sensitivity also makes sense. Those that are young have a longer work horizon ahead and should be less likely to accept much lower wages. While these results seem to be well-established, the above papers lack the capability to comment on the other main prediction of the systematic job search model: agents sample better firms first.²

²A couple other papers that affirm this observation include Fishe (1982) and Addison, Machado and
This result seems very straightforward and intuitive, but it is a feature that is absent in the prototypical random search models. Further, there are some underlying questions that are also important. What do workers deem as “better” jobs and how do they sort among them? Fortunately, the progressive increase in the availability of detailed proprietary data from large online job boards has better equipped researchers to address these (and many other) questions. What makes such data valuable is that it’s usually high frequency and it observes both sides of the market: employers and applicants. In any regard, these sources have become an integral part of empirical work in this area.

In one of such studies, Kudlyak, Lkhagvasuren and Sysuyev (2014) are able to address questions like those posed in the last paragraph using data from SnagAJob. The dataset includes daily information on all applications sent out to job postings on the website between September 2010 and April 2014 and contains information on a submitter’s age, gender, ethnicity, education level, and location. What is important in the early stages of this type of research is the definition of a “search period” as it governs the notion of “search effort” that is a fundamental aspect of these models. Some occupations might have a generally quicker call-back standard or might be relatively easier to apply to (a lower regard for formality, shorter applications, etc.). Thus, applying some number of times to firms in this occupation would require less effort than applying that same number of times in another occupation. In order to standardize this notion of effort across occupations, the authors define a search period as the unit of time that is long enough for a seeker to receive some signal about the outcome of an application.

The primary question raised by Kudlyak, Lkhagvasuren and Sysuyev (2014) is whether Portugal (2013).
or not workers with varying levels of education apply to different jobs throughout their unemployment spell. They split this into two broader problems. First, they look at whether or not applicants initially sort across jobs according to their education. Next, they look at how applicants direct their search over the rest of their search tenure. This is done because (as we will see) workers do, in fact, sort by education in their first search period and the insights of this stage can be used to construct an educational index of jobs that can be used as a proxy for job types (which are generally hard to characterize). With this notion of “type” we can thus see how the makeup of jobs applied to changes over time.

In the first search period of workers, the authors want to see if sorting occurs by education level. That is, do applicants with a college degree (16 years of education) apply for certain types of jobs and do high school graduates (12 years) apply to others? Gut instincts might incline us to expect that they do, but to what degree is still of interest. To get at this question the authors estimate the following,

$$e^i = \sum_j \mu^j \mathbb{I}(j \in J^{1,i}) + \varepsilon^i \quad \forall (i, j) : j \in J^{1,i}, \quad (5)$$

where $i$ indexes applicants, $j$ indexes jobs, $J^{1,i}$ is the set of jobs applied to by applicant $i$ in week 1, $e^i$ is the educational level in years of schooling, and $\mathbb{I}(\cdot)$ denotes the indicator function. Thus, the regression coefficients $\mu^j$ will be the average education level of all such first-period applicants for job $j$. To test whether or not applicants sort, then, is to test whether or not each of the $\mu^j$ coefficients are jointly equal (the null).

The $F$-statistics for this stage are all large with $p$-values of (about) 0.000 for all education (degree) levels. That is, there is strong evidence (at least less than the 1% level of significance) that agents sort according to their education at the beginning of their search for a job.
Knowing this suggests that particular job postings possess some notion of what “type” they are and that this can be proxied for by using the educational attainment of applicants to said job. Kudlyak, Lkhagvasuren and Sysuyev (2014) propose an educational index, $K_j$, that is the average educational level of each job $j$ of its applicants that apply to it in the first “search period” which begins when the posting receives its first application. Thus, jobs with a higher (implied) educational requirement will have higher values for this index than those without such a requirement.

Because the authors are concerned about how applications are directed as search tenure lengthens, the index is used to calculate an average relative index for jobs applied to by job seeker $i$ in search period $\tau$. The index is “relative” because the average market index is subtracted from each observation in this last calculation. In other words, this new construct, $\Delta k^i_\tau$, will be high in search period $\tau$ for individuals who apply to jobs with a higher than average educational index (and low for those who apply to lower than average jobs).

Finally, the second stage is carried out using the following specification.

$$\Delta k^i_\tau = c + \sum_{d=2}^{T} \eta^d \mathbb{I}(\tau^i = d) + \gamma^1 \Delta e^i_\tau + \sum_{d=2}^{T} \gamma^d \Delta e^i_\tau \mathbb{I}(\tau^i = d) + \alpha^i + \epsilon^i_\tau \quad (6)$$

Here, $\tau^i$ is the search tenure of applicant $i$, $\Delta e^i_\tau$ is the relative (to the average) “type” of applicant, and $\alpha^i$ are individual fixed effects. The $\eta^d$ coefficients will show the change in job types for which an average job seeker ($\Delta e^i_\tau = 0$) applies to in period $d$ compared to period 1. The $\gamma^d$ coefficients show the change in the strength of sorting between worker types and job types over time controlling for the initial sort (the $\gamma^1 \Delta e^i_\tau$ term).

Running the regression given by (6) reveals that the $\gamma$ coefficients are all distinguishable from zero and that $\hat{\gamma}^1 + \hat{\gamma}^d > 0$ and decreasing in $d$. This means that workers direct their
search in accordance to their educational attainment, but the strength of the way they sort
weakens as search continues. Interestingly, they find that most of the decline in this strength
happens in the first few weeks of search, and levels out thereafter. Next, the authors find
that $\eta^d$ are all negative and statistically distinguishable from zero and increasing (in absolute
value) in $d$. This is to say that the average agent searches systematically and applies to the
best, highest paying jobs first and then to lower-type firms, which agrees with the theory
developed by Salop (1973).

Overall, the theory of systematic job search seems to be well supported by the evidence.
The two primary predictions that fall out from the model, that the reservation wage declines
with search tenure and that agents sample better job opportunities first, are observed in the
data. In particular, it is found that “better” firms (or wage opportunities) align well with
the implied educational requirement of a job, and helps explain how workers direct their
search. Yet, the underlying model and insights seem to be lacking. Indeed, the treatment
of firms in this framework is rather limited. Firms, or jobs, are only explicitly mentioned
to construct the educational index in Kudlyak, Lkhagvasuren and Sysuyev (2014). Even so,
this index is constructed based worker; not firm characteristics.

While the previous paper does give a cursory prescription of firms, the following papers
will be more explicit. Moving forward, I turn to a modeling framework that gives a more
robust treatment of firms, competitive search. This framework can help address other labor
market observations and gives a more realistic understanding of the firm-worker relationship.
As such we will be better suited to comment on how workers direct their search.
3 Competitive Search

A key facet of the worker-firm relationship in the labor market that has been mostly absent thus far is wage determination. Theoretically, the two main ways of implementing this are bargaining and wage posting. In the former, the worker and the firm offering the job meet and negotiate the terms of the contract. Nash bargaining, for instance, involves the assignment of “bargaining power,” $\beta \in [0, 1]$, that captures the relative clout that each party has in maximizing the Nash product. Because the present paper focuses on directed search by the worker, the latter formulation of wage determination is naturally preferred.\(^3\) Wage posting, as is likely obvious, involves firms announcing what wages they will pay for work, enabling workers to select which firms to apply to. Following Moen (1997), the one who pioneered this modeling approach, the combination of both directed search and wage posting is called competitive search.

3.1 Theory

There are two equivalent approaches advanced in the literature that establish the competitive search environment (Rogerson, Shimer and Wright, 2005). One presumes a “market maker” who creates submarkets such that wages can vary across submarkets but must be constant within one. Firms and workers, then, decide which submarkets to enter in accordance with their respective maximization problem. The other environment has employers post wages themselves and workers direct their applications to the most attractive offers. Higher wages

\(^3\)Indeed, the question of whether or not to post wages or to bargain (amongst other options) is important for topic of firm recruitment, which is not directly looked at here.
attract more applicants, and thus result in a lower probability of landing a job for any particular worker. Below is an overview of the basic, and original, model by Moen (1997). Following, I briefly describe other manifestations of the competitive search model and some of their extensions and implications.

In continuous time there is a unit measure of risk neutral workers and an endogenous measure of jobs determined through free entry.\(^4\) Risk neutral firms can open a vacancy by incurring a sunk cost \(k\). When this cost is paid a productivity \(y \in \{y_1, \ldots, y_n\}\) for the vacancy is drawn from some distribution \(F\). Matches in a submarket are made corresponding to a constant returns to scale matching function \(x\) that depends on the amount unemployed and the number of vacancies in the submarket.\(^5\) In submarket \(i\) the poisson arrival rate of job offers and of workers to vacancies as \(p(\theta_i) = x(u_i, v_i)/u_i\) and \(q(\theta_i) = x(u_i, v_i)/v_i\), respectively, where \(\theta = v/u\) is labor market tightness. As is common in the broader search literature, it is assumed that \(p(0) = q(\infty) = 0\) and \(p(\infty) = q(0) = \infty\).

Unemployed workers receive benefits \(b\) and employers are separated from their jobs at rate \(s\). Agents discount at the rate \(r\) and observe the wages offered in each submarket, \(w_i\), and decide which one to enter. Firms, on the other hand, must pay a cost \(c\) to search (we can think of this as a payment to maintain a job ad). The asset values of unemployment,

\(^4\)It is common to assume that each firm can create only 1 job. Burdett, Shi and Wright (2001) explain that the distinction may matter. I explain this in more detail below.

\(^5\)Burdett, Shi and Wright (2001) also explain that this might be problematic in a finite setting, but that as \(\theta\) tends to infinity, CRS holds.
employment, a vacancy, and a filled job are given by

\[ rU_i = b + p(\theta_i)[E_i - U_i] \]  

(7)

\[ rE_i = w_i - s[E_i - U_i] \]  

(8)

\[ rV(y_i, w, \theta) = -c + q(\theta)[J(y_i, w) - V(y_i, w, \theta)] \]  

(9)

\[ rJ(y_i, w) = y_i - w - sJ(y_i, w). \]  

(10)

By assuming homogenous workers, the different submarkets (which may still offer different wages) must attract workers equally, meaning that each submarket offers the same expected income. Firms choose which submarket (i.e. they choose a wage) that maximizes their expected profit. Workers will prefer to work at high wage firms but must face a tradeoff in that they are competing against more applicants. That is, firms offering high wages will attract more workers, but individual workers will be less likely to land the job. Interestingly, the equilibrium given by these maximization problems is socially efficient, which wouldn’t necessarily be the case if wages were determined via bargaining.

There are many interesting, and revealing, extensions of this basic framework. For starters, workers were assumed to be homogenous. This can be relaxed and doing so only adds to the analytic difficulty of the solution. Next, allow agents to receive different amounts of unemployment insurance, \( b_i \). In such a scenario, workers with higher benefits will direct their search to submarkets with higher wages. This agrees with the idea of the reservation wage strategy: if staying unemployed is relatively less costly, workers will direct to higher wage firms even if the likelihood of landing these jobs is lower. In other words, they demand a higher wage in compensation for giving up higher benefits. Still, other papers have proposed alternative competitive search environments that yield additional insights.
Instead of assuming that firms set wages according to some notion of aggregate conditions, Burdett, Shi and Wright (2001) explicitly take into account the strategic interactions between sellers. They suppose some finite number of firms who compete to maximize profits subject to the behavior of other firms competing for a finite number of workers. In the symmetric equilibrium they are able to derive a closed form for the matching function which turns out to have diminishing returns, suggesting that the common CRS assumption in the literature is misspecified in a finite setting. Further, they allow firms to be heterogeneous in their capacities and find that the wage and matching effects of an increase in capacity (the intensive margin) are different than the wage and matching effects of an increase in the number of firms (the extensive margin). Altogether, this suggests that the key variables of the economy, including the wages that workers direct to, depends on how firms are modeled (as containing a single job or multiple jobs). As a limiting case, as the number of firms and workers both tend to infinity (at the same rate), Burdett, Shi and Wright (2001) show that their results converge to the CRS case used in the literature.

Shimer (2005) does something similar and looks at heterogeneous agents and firms, but allows firms to offer type-contingent wage schedules. This contrasts with the requirement that firms only post one wage. Here different types of workers can direct their applications to different types of firms, and, in equilibrium, there can be similar workers earning different wages and similar firms employing different workers. This speaks to an important finding of this paper, that workers assortatively match with firms with positive correlation between

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6In Moen (1997) sellers are limited in some sense by a free entry condition.
7That is, the “interesting” equilibrium that does not require an impractical degree coordination.
8The form derived in this paper is often referred to as the urn-ball function. See Petrongolo and Pissarides (2001) for an in-depth analysis of the different matching functions used in the search literature.
types, but that this correlation is not perfect.\footnote{There are a lot subtleties that go into producing this assortative matching that are not directly related to the wage schedule addition. For an in-depth examination of the conditions needed for assortative matching, see Shimer and Smith (2000)} Important for the scope of the present paper is the result that a single type of worker optimally decides to apply to different types of firms, and seems to provide theoretical support of an empirical observation that otherwise similar workers can have vastly different labor market outcomes (Abowd, Kramarz and Margolis, 1999). Next, I turn to the empirical evidence for (and against) some of the above results.

3.2 Evidence

A major component of the competitive search framework is wage posting. Indeed, this is the most natural way to enable workers the ability to distinguish between firms so they may direct their applications. However, what does the evidence look like for wage posting? A lot (though not exclusively so) of recent research has shown that wage posting is relatively rare (Brencic, 2012; Marinescu and Wolthoff, 2015; Brown and Matsa, 2015). Further, these studies have identified some interesting alternative ways that workers distinguish between firms offering jobs. The first of a pair of studies that I look at below suggests that job titles themselves are important while the second looks more closely at firm reputations. While these findings might seem to discredit the basic competitive search framework, I argue that the results point to a more loose interpretation of wage posting as a multidimensional mechanism by which workers evaluate their earning prospects or callback probability at certain jobs.

Making use of high frequency data on applications and job postings from CareerBuilder.com, Marinescu and Wolthoff (2015) explore the importance of a piece of information not usually

Marinescu and Wolthoff (2015) explore the importance of a piece of information not usually
considered in the literature, the job title. First, they note that only 20% of job listings post a wage, whereas they all post a title. One of the authors’ hypotheses is that wage information is implicit in the job title. To test this, the authors run a regression of the logarithm of the posted wage on job title fixed effects, firm fixed effects, and a set of job characteristic controls. The results show that these variables help explain over 93% of the variation in posted wages and, when restricting the focus to within a Standard Occupational Classification (SOC) code, job titles can explain over 90% of the variation in wages.\textsuperscript{10}

Next, Marinescu and Wolthoff (2015) look at the behavior of workers’ application patterns in relation to job titles. Looking first at the relationship between wages and applications, they find that high wage firms get fewer applications when using SOC level controls. While this is in direct contradiction with the theoretical predictions, the authors show that when controlling at the job title level (which, again, is more specific), the highest wage jobs are indeed the ones most applied to, affirming the theory. The regression results indicate that a 10% increase in the wage is associated with a 7.4% increase in applications.\textsuperscript{11} This result is also more specifically explored by Marinescu and Wolthoff (2012).

The authors also explore how the types of applicants sort across jobs. In a regression of the applicant’s experience on job title fixed effects and the logarithm of the posted wage and finds that job titles explain 95% of the variance in the education of workers across jobs. A similar regression, with education as the dependent variable, reveals that job titles can

\textsuperscript{10}These six-digit codes are a common “job level” control used in the previous literature. An underlying finding of this paper is that these codes are too broad to capture the idiosyncracies in the jobs they encompass.

\textsuperscript{11}It should be made clear that while CareerBuilder.com has a diverse set of jobs, there are not “upper tail” type jobs such as medical doctors, which we might expect to not get too many applications despite offering very high wages.
also explain about 85% of the variation in education across jobs. Altogether, these findings suggest that, using the title of a job, workers direct (not randomize) their search and sort according to type, with low-skill and high-skill applicants generally apply to low-wage and high-wage jobs, respectively, lending some support for Shimer (2005).

In another application of large online job board data, Brown and Matsa (2015) look at how workers use financial information on prospective employers in guiding their application decisions. Using multiple proprietary datasets, they utilize equity and credit default swap (CDS) positions as measures of firms’ financial conditions during the recent financial crisis. The first dataset contains high frequency applicant level information on which firms they applied to on the job website with a set of controls from their profiles. The second dataset contains information on forty high-profile financial service firms that utilize this website. Their detailed research and identification strategy exploits large variation in CDS prices (both within and between firms) and is accomplished in two parts.

In the first part, Brown and Matsa (2015) test whether or not workers adequately assess the financial conditions of the firms offering jobs on the website over time using survey responses of users. The idea is to test whether or not workers’ beliefs are able to be proxied for and how confident we can be with workers’ abilities to identify turns, or changes, in these conditions. Matching equity and CDS prices held by these firms with the responses of the websites users, the authors find that survey scores (measured on a 1-5 scale with “very weak” being 1 and “very strong” being 5) adequately reflect and respond to the overall standing of the firm. For example, when CDS prices increase by 1 standard deviation (a sign of a weakening status), survey scores decline by around .5 standard deviations. This result

\footnote{The names of which are protected by a non-disclosure agreement.}
is robust to the inclusion of industry and quarter fixed effects and holds for both financial and non-financial firms.

In the second part of the study, Brown and Matsa (2015) look at whether or not workers act on this information through the way they apply. Running a panel regression with time, location, and job fixed effects, they find that a 10 cent increase in price of 1 dollar of default protection reduces the number of applications by 20 percent (significant at the 1 percent level). That is, this suggests that information on how distressed a firm is significantly affects which firms to direct to. This result is also robust to multiple alternative specifications. Important to note, though, is that there are multiple mechanisms by which this result could be made. Specifically, the negative relationship could be generated through a change in labor supply (which was advanced above) or through a change in labor demand (possibly both).

Regarding the demand mechanism, it is entirely plausible that firms undergoing a lot of financial hardship reduce their need for new employees or require more specialized types of employees, and so reduce the number or makeup of job postings. Because of the detailed data, the authors can actually track the composition of job titles at individual firms over time and find that it doesn’t change with a change in default risk. To make sure that firms are not otherwise constrained in their ability to employ new workers, the authors also examine the offered salaries by each firm and find that offered wages increase, rather than decrease, when under financial strain. The implication of the above points to the labor supply mechanism as the driving force of these observations.

In sum, properly modeling firms can be insightful into for how we view a worker’s decision on where to apply. Theoretically, wage posting is the common route. Empirically, though, we observe that very few firms actually use this method to attract workers. Instead, there
is evidence that workers extract the relevant information necessary to evaluate their wage earning prospects via other channels, namely the job title or company fundamentals. While this does not necessarily discredit the pure theory, it reveals some of the present limitations of that theory and can help guide future work. To this end I discuss next.

## 4 Extensions

The theory of directed search provides some testable predictions of worker application strategies that, for the most part, we observe in the data. As we have seen, though, there are shortfalls of the theory, specifically with regard to the institution of wage posting. Still, these shortfalls can loosely be interpreted broadly as alternative information channels by which workers evaluate their wage earning (or job landing) prospects. However, this relaxed interpretation can only get us so far in explaining empirical observations. One such observation that does not so easily fit the competitive search framework that has become an increasingly popular topic of study is that workers, in large numbers, find employment with firms that their friends (or their friends of friends) work at.

*Gee, Jones and Burke (2015)* document this observation using detailed Facebook.com data to get an idea about how networks, here social networks, impact the search for jobs of individuals. In the networking literature, two concepts, “strong” and “weak” ties, are a common area of study and a focus for a debate surrounding how valuable each one is in acquiring a job. Briefly, ties are connections between individuals in a network. A strong tie reflects things like close friendships or direct friendships. A weak tie, by comparison, can be though of as a “friend of a friend.” An early paper studying this phenomenon by Granovetter...
(1973) concluded that it was weak ties that were the ones that mattered in finding a job. Gee, Jones and Burke (2015), though, determine that stronger ties are more valuable at the margin, and that the earlier result is driven primarily by the fact that weak ties are more numerous.

In any regard, that 50% of workers end up working with a friend is very suggestive about how workers search for jobs (Gee, Jones and Burke, 2015). Further, it cannot be explained by or explored in the frameworks reviewed here, nor of the random search literature. From a theoretical standpoint, I think that there is much to be desired on this front. While there are some models of endogenous networks, none (to the best of my knowledge) combine the issues of directed search and network formation in the pursuit of employment. In doing so I feel that both of these literatures would benefit.

There are a few questions I would like to see tackled in future research, specifically about the possible extension highlighted above. First, how would the results of the current models change when adding in a use for worker networks. To motivate this, it should be noted that, in typical search models, the only nontrivial decision is whether or not a firm should open a vacancy. By adding in a structure and need for networks in aiding the process to find a job, however, the strategic decisions by agents to “link” or form a friendship might provide some useful insights. Just as with Burdett, Shi and Wright (2001), which found that the standard models were misspecified along multiple dimensions when allowing firms to compete for workers (by removing the no economic profits assumption), there might also be other changes when allowing workers to compete for friends.

To give one example, the theory tells us that agents apply to firms with the best wage earning prospects. By making it easier to find a job with a friend, we might see agents apply
to firms that they normally would not apply to. This could also contribute to the worker recruitment literature. For instance, can firms cut on the costs associated with advertising a vacancy by sampling on the friends of its current workers? Lastly, from a preferences mindset, the above extension might be able to comment on what workers look for in a job. That is, working with people you know might be important in determining where a worker applies that is not captured by either the wage or the probability of landing a job.

5 Conclusion

Search models are very useful tools that can capture market frictions, for example a coordination problem, in labor markets. These frameworks can explain why unemployed workers and unfilled vacancies can coexist in equilibrium, or why some agents will decline job offers. Models of directed search, in particular systematic job search and competitive search, have proven useful in describing some stylized facts observed in empirical studies.

Compared to random search models, which presume job-seeking workers and firms must “hope” to match up with each other, the models explored here posit that workers have some ex ante knowledge of firms and can choose where to apply. This is an appealing feature considering it mirrors reality. Further, it generates additional results that match the data reasonably well. For starters, agents typically apply first to firms with better expected wage outlooks and get less choosy as search tenure lengthens. These “better” wage opportunities seem to be nicely captured by differences in educational attainment insofar as education level is an important sorting mechanism for workers to direct their search.

The simplest models of directed search, though, are limited in their treatment of firms.
Competitive search models, in contrast, are more rigorous on this front and can help explain why we observe similar workers working at different firms or why similar firms employ different types of workers. Still, these structural models can only take us so far. There are some things that are not adequately documented in such frameworks that are still prevalent and important in real life. Above I have noted one of such observations: in large numbers workers find employment with their friends.

Moving forward, I feel like this will be a fruitful area for new research, both on the theoretical and empirical sides. As more and more data are made available to researchers, such as the Facebook.com data obtained by Gee, Jones and Burke (2015), more can be learned about the inner working of networks and their true importance in directing search to find a job. More broadly, the greater availability of detailed job board data can help bridge the gap between theory and empirics as more facets of the decision to work or hire can be tested and scrutinized considering we are now capable of observing both sides of the market. In any regard, there is a lot of room for advancement for the study of how workers direct their search.

References


Gee, Laura, Jason Jones, and Moira Burke. 2015. “Social Networks and Labor Markets: How Strong Ties Relate to Job Transmission Using Facebook’s Social Network.” available from Laura K. Gee by request.


