

Advertising and Labor Market Matching: A Tour Through the Times*

Jed DeVaro[†] Oliver Gürtler[‡]

October 25, 2013

Abstract

Surveying newspapers spanning multiple countries and four centuries, we identify four eras of employment-related advertising (neither workers nor firms regularly posted ads, mostly workers posted, mostly firms posted, both parties regularly posted). Modeling the job matching process as a strategic coordination game, we identify multiple equilibria suggesting three complementary explanations for transitions across eras: an increase in firm size over time, an increase in worker mobility and a reduction in search frictions, and a decrease over time in the workers' relative value of labor versus unemployment. The model exhibits a discontinuous welfare function, suggesting important policy implications for job matching.

Keywords: labor market matching, recruitment, job search, newspaper advertising

JEL Classification: J23, J63, M51, N3

*We thank Vera Brenčić, Lisa Dickmanns, Kaj Gittings, Fidan Ana Kurtulus, and seminar participants at Universidad Carlos III de Madrid, Osaka University, the OEIO 70th Meeting, Tokyo Conference, and California State University, East Bay, for helpful comments, and Roza Trilesskaya for research assistance.

[†]Department of Management and Department of Economics, College of Business and Economics, California State University, East Bay, Hayward, CA 94542, phone: (510)885-3289, e-mail: jed.devaro@csueastbay.edu.

[‡]Department of Economics, University of Cologne, Albertus-Magnus-Platz, D-50923 Cologne, Germany, phone: +49 221 4701450, e-mail: oliver.guertler@uni-koeln.de.

1 Introduction

The matching of job seekers to employers is a fundamental subject in labor economics that also has implications for macroeconomic discussions of unemployment. Furthermore, understanding the impacts of many labor market and macroeconomic policies hinges on what we know about the job matching process. The matching framework (e.g. Pissarides 2000, Mortensen and Pissarides 1999) posits a matching function that summarizes, in the aggregate, the outcomes of encounters between job seekers and recruiting employers. The matching function reflects the transaction costs and search frictions arising from imperfect information.¹ To combat these frictions, both sides of the market can influence the matching function by making investments that improve information.² But which side of the market should make those investments? How do the investments made by one side of the market influence those made by the other side? What are the implications of having the investments occur on one side of the market versus the other? Answering such questions requires shining light “under the hood” of the matching function, as we do in this study.

Although search-related investments are implicit in the matching function, they are rarely the primary objects of research interest.³ Furthermore, when search strategies are in the spotlight the focus is typically on the behavior of only one side of the labor market, and strategic interactions between the job seeker and the employer are ignored.⁴ Our goal is to learn about the job matching process by investigating how advertising behaviors of employers and job seekers have changed historically and by developing an explanatory theoretical framework that accounts for strategic interactions in these investments.

We start by reading the employment-related ads in newspapers – lots of them, spanning over four hundred years, multiple languages, and locations as diverse as Austria, England, Ireland, Scotland, the United States and its original

¹See Petrongolo and Pissarides (2001) for a survey of the matching function.

²For example, job seekers can learn about job vacancies by exploiting personal networks of friends and relatives, reading job ads online or in the newspaper, contacting state or community employment agencies, and attending university career fairs, whereas employers can learn about prospective hires by soliciting the referrals of current employees and friends, posting “help wanted” signs or ads online or in newspapers, consulting unions or state employment agencies, or attending university career fairs.

³The literature on employer recruitment strategies, for example, remains a backwater. A quote from Granovetter’s seminal work in the early 1970s still rings true today: “While people are finding jobs, employers are finding people to fill them, and their behaviors, strategies, and purposes play a central but often neglected role in the process of matching people to jobs” (Granovetter 1995).

⁴For example, although employer recruitment strategies were treated as endogenous choices in DeVaro (2008), job seeker search strategies were not modeled in that analysis.

colonies, Jamaica, Barbados, India, and seventeenth-century Strasbourg. Based on this reading, we identify four eras in advertising history. Until the 19th century, newspaper ads posted by either employers or job seekers were rare, and we call this the “Pre-Ad era”. When ads began to appear regularly starting in the nineteenth century, those posted by job seekers tended to dominate the market, and we call this the “Early era”. For example, the October 24, 1871 edition of *The New York Times* contained 138 employment-related ads, only 8 of which were employer-posted “Help Wanted” ads, featuring a dozen positions for cooks, canvassers, coachmen, seamstresses, chambermaids, waitresses, laundresses, and an opportunity in a life insurance office. The remaining 130 were “Situations Wanted” ads, divided into a section for females and another for males. A dramatic reversal then occurred, such that by the late twentieth century nearly all ads were posted by employers, and we call this the “Modern era”. For example, the October 24, 1971 edition of *The New York Times* contained thousands of ads, and we estimate that about 96 percent of them were posted by employers.⁵ So less than 6 percent of the ads on October 24, 1871 were employer posted, versus 96 percent in the same newspaper, on the same date, a century later. Finally, the advent of the internet allowed electronic ads to be posted at low cost, resulting in today’s significant volume of online posting by both sides of the labor market.⁶ We call this the “Internet era”. After documenting these intriguing observations, we develop a theoretical model that can explain all of them. The model exhibits equilibria corresponding to each of the four eras and suggests several complementary explanations for the historical evolution across the equilibria.

Although we focus on the labor market, the question of which side of the market should undertake search-related investments is quite general, and for that reason the theory we develop could apply to other matching markets (e.g. the rental housing market, in which both sides of the market regularly post

⁵Sunday, October 24, 1971 can be considered a randomly selected date, except to the one of us who was born on it! Since the ads on that date are so numerous, we approximated the fraction posted by employers. The main collection of ads spans all of Section 9 (pages 1-34). Each column of text on a page contains dozens of individual ads, and there are 303 columns of ads in total in Section 9. Fewer than 12 of those columns contain “situations wanted” ads posted by job seekers. These numbers form the basis for our estimate of 96 percent, though in fact the fraction of total ads placed by employers was even larger, since there are some other locations in the newspaper containing scattered employer-posted ads. For example, ads can be found in the business section between pages 17 and 30, and ads for teachers can be found on pages 12 and 13 of Section 4.

⁶It is now common for job seekers to post ads (typically in the form of résumés on sites like monster.com and professional networking sites like LinkedIn) as well as employers.

on websites such as craigslist). The following example illustrates the generality of the investment problem. Two blindfolded individuals are randomly located at different positions on an empty playing field. Their objective is to find each other to collect a shared prize, and the rules prevent them from communicating. Each is free to remove his blindfold at a cost. If neither chooses to do so, they might never find each other. If one of them removes the blindfold, they should find each other easily, and a positive externality is created by the party who invests. And given that one of them removes the blindfold, there is little benefit to the other of removing the blindfold, which creates the potential for free riding. There are four possible outcomes: both blindfolds remain on, both are removed, or two distinct ways in which only one is removed. But which outcome(s) prevail, and why? In the special case of the labor market, our review of the newspaper evidence reveals that the four “blindfold outcomes” are reminiscent of the four advertising eras that have occurred historically.

Our model is a strategic game of coordination involving N homogeneous job seekers and a single firm that could employ up to N workers.⁷ In the first of three stages, workers and the firm simultaneously decide whether to post an ad and whether to read the newspaper in search of ads. If the firm decides to read ads, it also chooses how many ads to read. Both posting and reading are costly activities for workers and the firm. Matches occur in the second stage, with match probabilities influenced by who posts and reads in the first stage. Hiring occurs in stage 3, when payoffs accrue to both sides of the labor market in the form of wages and profits.

In the simplest case of a two-player game with one worker ($n = 1$) and one firm, the model exhibits the following four pure-strategy equilibria, analogous to the four “blindfold outcomes” from our example: neither side posts or reads, both sides post and read, the firm posts and the worker reads, or the worker posts and the firm reads. In the more interesting case of multiple workers, an additional equilibrium emerges. More precisely, the model exhibits five pure-strategy equilibria. In the type-A equilibrium, neither side posts, and neither side reads. In the type-B equilibrium the firm posts but does not read ads, and all workers read ads but do not post them. In the type-C equilibrium the firm

⁷Our assumption of homogeneous preferences differs from the matching literature, originating with Gale and Shapley (1962) and subsequently developed by Roth and others, in which heterogeneity of preferences is key. The notion of match stability is therefore irrelevant in our model, and our welfare analysis has a somewhat different flavor. In the matching literature, social welfare hinges on the exact configuration of matches, whereas in our model one match is as good as any other, and the welfare analysis hinges on the likelihood that a match occurs at all and on who pays the investment costs to increase the likelihood of a match.

reads ads but does not post, and all workers post but do not read ads. In the type-D equilibrium the firm and all workers post and read ads. The type-E equilibrium matches the type-D equilibrium but with the following difference. Only some of the workers post, and the firm reads fewer ads than in the type-D equilibrium. We also extend the model to two firms. Although the analysis becomes largely intractable in that case due to a proliferation of potential pure strategy equilibria, we can show that equilibria exist that have similar properties to those in the single-firm model.

The equilibria just defined match or approximate the behaviors we have observed in the historical record. The Pre-Ad era was characterized by essentially no posting (and therefore presumably little reading) by either side of the market and is well described by the type-A equilibrium. Advertising in the Early era was dominated by job seekers, although a small fraction of employer-posted ads also appeared, and there are two ways to understand this era in the context of our model. One possibility is that the equilibrium of type D applies, and perhaps E during the later part of this era as the fraction of worker-posted ads shrinks. Another possibility is that equilibria of types B and C were both sustainable during this era, implying that the structure of the game resembles that of battle of the sexes. The observed behavior could then be explained in two ways: either some people failed to coordinate on the correct equilibrium or some occupations and industries played equilibrium B and others played C. The Modern era in which advertising was dominated by employers is well described by the type-B equilibrium. The current Internet era in which both sides regularly post and read online ads is well described by the type-D equilibrium.

We attribute the transition from the Pre-Ad to the Early era to decreases in the costs of posting and reading ads that occurred because of increasing literacy rates, which in turn were fueled by the technological progress that accompanied the Industrial Revolution and by the growth of public school systems. Similarly, we attribute the transition from the Modern to the Internet era to decreases in the costs of posting and reading ads that occurred because of the Internet Revolution. We provide three complementary explanations for the transition from the Early to the Modern era: a growth in firm size over time, an increase in job mobility and a reduction in search frictions over time, and an increase over time in the jobseekers' outside option of unemployment, due to the emergence of social insurance programs in the twentieth century. We elaborate on all of these explanations after developing the theoretical model.

This work relates to a literature on recruitment that dates back at least as

far as Malm (1954, 1955). The role of employer recruitment strategies as an information generating device was first explored in Rees (1966).⁸ Since Rees and Shultz (1970), much of the literature on recruitment and worker job search has focused on the role of informal methods (such as soliciting referrals from current employees, friends, or relatives) in labor market matching. For example, Pinkston (2012) and Simon and Warner (1992) conducted empirical tests of the hypothesis that informal referrals generate more precise information about job applicants than other recruitment methods.⁹ DeVaro (2005) analyzed how a variety of recruitment methods relate to vacancy durations and starting wages.¹⁰ The recruitment methods considered included informal methods and a variety of formal methods (such as newspaper advertising), though consistent with most of the literature all of the recruiting methods were treated as exogenous. In a related analysis, DeVaro (2008) estimated a dynamic structural model to identify the effects of recruiting channels on starting wages and vacancy duration, treating recruitment methods as endogenous. The key tradeoff in that model is that informal methods (consistent with the arguments in Rees and Shultz and the subsequent literature) are expected to yield higher-quality matches, whereas formal methods such as newspaper advertising generate a larger applicant pool from which the employer can be more selective. Our focus is on formal methods (and in particular advertising) rather than informal methods.

The work also relates to a growing literature on two-sided markets (or networks).¹¹ These markets involve a “platform” that facilitates transactions between two “end users”, getting both parties “on board”. For example, a credit card platform connects buyers and vendors; the credit card network can attract customers if stores accept its card, but stores will only accept the card if there are many customers. In our context, the platform is the newspaper, the end users are job seekers and employers, and “getting both sides on board” means commencing an employment relationship. This corresponds to the rough defin-

⁸The crucial role that information plays in the labor market has been appreciated since Stigler (1962).

⁹See also Lounsbury (2006), Castilla (2005), Kugler (2003), Mencken and Winfield (1998), Mortensen and Vishwanath (1994), Montgomery (1991), Blau and Robins (1990), and Holzer (1987,1988). While the idea that informally recruited new hires could yield better matches became popular following Rees (1966) and Rees and Shultz (1970) it had also been noted earlier. For example, Reynolds (1951) discussed a retention benefit deriving from workforce congeniality and residential co-location.

¹⁰See also Brenčić (2009), Barron et al. (1997), Gorter et al. (1996), van Ours and Ridder (1992), and Roper (1988).

¹¹See, for example, Rochet and Tirole (2003, 2006), Parker and Van Alstyne (2005), Rysman (2009), Weyl (2010), and Eisenmann, Parker, and Van Alstyne (2011).

ition of a two-sided market offered in Rochet and Tirole (2006), which cited the newspaper as an example that competes for advertisers as well as “eyeballs”. The theory relates to an older literature on network externalities (originating with Katz and Shapiro 1985 and 1986, and Farrell and Saloner 1985 and 1986) by assuming that there are non-internalized externalities among end users. For example, if a store accepts a credit card, it creates a positive externality for customers who want to use that card. In our model, the firm creates positive externalities for the workers by posting or reading ads, and workers create positive externalities for each other and for the firm by posting or reading ads.¹²

Our model delivers important and unexpected welfare implications. For example, policies that hinder job mobility and increase search frictions can actually enhance welfare, if they sufficiently weaken the incentive of one side of the market to free ride on the investments of the other. The positive externalities resulting from the additional investments that occur when both sides of the market post and read ads may outweigh the negative effect on welfare of a reduction in job mobility and increase in search frictions. Similarly, small labor market interventions to increase job mobility and reduce search frictions can lead to large reductions in welfare that arise when one side of the labor market is induced to free ride on the investments made by the other side, thereby lowering the positive externalities associated with search-related activities. An implication of these arguments is that policies aimed at reducing the costs of posting and reading ads may be superior to those designed to increase job mobility and reduce search frictions. More generally, because of the multiplicity of equilibria, changes in the model parameters (from policy interventions or for other reasons) change welfare in two ways. First, conditional on a specific equilibrium being played, changes in the model parameters affect workers’ and firms’ payoff in this equilibrium. Second, changes in the model parameters may induce workers and firms to behave differently, i.e. to switch to a different equilibrium. Because of this latter effect, a small change in one of the model parameters may have a large effect on welfare (i.e. the welfare function is discontinuous). This gives

¹²Given our assumption that there is no scarcity in jobs, workers’ decisions to post or read ads impose no negative externalities on other workers, though assuming a job slot constraint would change that and would guarantee equilibrium unemployment. Similarly, even without scarcity in the number of potential jobs, workers’ decisions to post would impose negative externalities on each other if the firm’s probability of discovering a given worker’s ad were a decreasing function of the number of worker ads posted. This modeling assumption would be a way to capture a congestion effect. We abstract from job scarcity and congestion, since these features would complicate the analysis without deepening the model’s insight, so the only non-internalized externalities are the positive ones just stated.

rise to a range of policy implications such as those just described.

2 Employment-related advertising: a tour through the *Times*

Employment-related advertising has surely existed, in some form, for as long as there have been labor markets. One longstanding method of advertising that is still used is physically posting a visible indicator, such as a “Help Wanted” sign, in a public area or storefront window. This method is simple, effective, and cheap, though a downside is that people must attend the physical location to notice the ad, and they have no way of knowing in advance whether they will find an ad if they visit a particular location.¹³ Today, the problem of reaching a large audience without requiring readers to travel to a physical location has been solved by the internet, and ads increasingly appear on job matching sites like monster.com, or on professional networking sites like LinkedIn. The electronic ad, however, is a recent phenomenon. Between these two extremes of the internet and physically posted ads lies the newspaper, which emerged in the early seventeenth century.¹⁴ For centuries preceding the advent of the internet, the newspaper offered both sides of the labor market their best option to reach a widely dispersed audience at a reasonable cost.¹⁵

The advent of the newspaper induced a massive drop in the cost of disseminating information quickly to a large audience spread over a wide geographic area, so it is natural to expect that the newspaper would have evolved rapidly into an important vehicle for labor market matching. But our investigation suggests that employment-related newspaper advertising did not become a regular phenomenon until the nineteenth century. To establish this fact, we read

¹³This method is also used by the other side of the labor market. For example, in some California cities job seekers congregate in a collectively known location that is frequented by roofing contractors (e.g., a Home Depot). When the contractors arrive at the store to purchase the materials needed for that day’s work, they hire these day laborers on the spot to help with the roofing projects for that day. Thus, the job seekers advertise their availability by “posting” their own physical presence at a given location.

¹⁴As noted in Weber (2006), the first newspaper appears to be *Relation aller Fürnemmen und gedenckwürdigen Historien*, which was founded in Strasbourg in 1605 and published in German.

¹⁵Televised job ads have never been very popular. Even though they can reach a large audience immediately and without requiring consumers to attend a particular location, the cost of air time is high. Furthermore, a newspaper can be read at one’s leisure, and the reader knows where in the newspaper to find all of the ads in one place. In contrast, television ads appear individually and sporadically and must be consumed contemporaneously.

many newspapers, printed in both English and German, spanning many geographic areas, and dating back to 1609. Although we provide a summary in Table 1, our review was more exhaustive than what we have displayed in the table.¹⁶ We see that prior to the start of the Industrial Revolution around 1760, employment-related advertising by either side of the labor market was virtually non-existent. We found no ads in the newspapers we read from the seventeenth century. The oldest ad we found was posted by a job seeker named Thomas Ward in *The Weekly Jamaica Courant* on July 30, 1718. For the remainder of the eighteenth century, ads appeared only sporadically, sometimes posted by job seekers and sometimes by employers. Since ads were extremely rare during the period covered in Table 1, we refer to this as the “Pre-Ad” era. In the context of the theoretical model we develop in the next section, the Pre-Ad era is best described by the type-A equilibrium in which neither employers nor job seekers post or read ads.

To document what happened during the period of regular posting that emerged in the nineteenth century, we provide a tour through the histories of two celebrated and currently circulating newspapers, namely *The Times* of London and of New York.¹⁷ We begin with the London newspaper. Table 2 displays a tour through *The Times*, from 1785 through 1991. We examined the October 24 editions at intervals of a decade, stopping in 1991 since that was the last year for which we had convenient microfilm access and because that date was sufficiently late for our purposes.¹⁸ If October 24 fell on a Sunday during a year in which *The Times* did not have a Sunday edition, we used the edition from an adjacent day. Our objective was to see whether employment-related ads were posted mostly by employers, mostly by job seekers, or regularly by

¹⁶We did a particularly thorough investigation of *The Maryland Gazette*, starting with the 1745 issues that were readily available to us on microfilm. Founded in 1727, *The Gazette* is one of the oldest newspapers in the United States. Perusing many issues, we found no employment-related ads from 1745 through the early nineteenth century.

¹⁷We selected these newspapers because of their long histories, international reputations and stature, and diverse geographic locations. According to Wikipedia, the printed version of *The New York Times* remains the largest local metropolitan newspaper in the U.S. and the third-largest newspaper overall, behind *The Wall Street Journal* and *USA Today*. *The New York Times* website receives more than 30 million unique visitors per month (Adams 2011) making it the most popular newspaper website in the U.S. The London newspaper was founded on January 1, 1785 as *The Daily Universal Register*. On January 1, 1788, it changed its name to *The Times*, becoming the first of many newspapers in the world to bear that name. Since the arrival of other *Times* newspapers (e.g. *The New York Times*), the longer title “*The London Times*” has often been used for distinguishing purposes. The New York newspaper was founded in 1851 as *The New-York Daily Times*, dropping the hyphen and the “*Daily*” in 1857.

¹⁸We also considered a number of other randomly selected dates to assure ourselves that there is nothing special about October 24.

both sides of the labor market. In most years we provide an exact count of ads, though we provide approximations for years in which the quantity of ads is overwhelmingly large or in which counting is otherwise inconvenient. As seen in the first three rows of Table 2, the absence of ads in 1785 and 1795 and the paucity of ads in 1805 are consistent with the conclusion we drew from Table 1. Table 2 reveals that employment-related ads were not a regular phenomenon until the nineteenth century was well underway.

The next several rows of Table 2 reveal that when employment-related ads became a regular fixture in the newspaper, they were dominated by job seekers rather than by employers. The year 1845 was an exception given that the fraction of ads posted by employers reached nearly 43 percent, but even then the fraction was well under half. By 1855 that number dropped back down to 17.5 and remained under 30 percent for the rest of the century. Our impression is that 1845 was anomalous and driven by the railway boom witnessed by London in the 1840s. A lot happened on the railway front in London between the years of 1835 and 1845. The Euston terminus was built at the end of the line from Birmingham, bringing long distance railroad travel to London in 1837. Two other major terminals followed, with Paddington opening in 1838 and Fenchurch Street opening in 1841. Permission was also sought from Parliament for 19 new railway lines in London. The early 1840s also witnessed an increase in government regulation of the railways, such as the Railway Regulation Acts of 1840 and 1844. Many of the ads in the 1845 newspaper suggest a considerable and immediate demand for labor on the railways, often at high wages. The following ads from that edition - all of which appear in a single column on the front page of the newspaper - are representative:

TO SURVEYORS AND LEVELLERS. -WANTED, from 20 to 30 first-rate HANDS, to whom a liberal payment will be given. Apply, by letter post paid, to C.E., care of J.E. McCabe, surveyor and lithographer, 35 Castle Street, Holborn [illegible].

TO SURVEYORS AND LEVELLERS. -WANTED, immediately, a PERSON to teach surveying and levelling, one who has the proper instruments will be preferred. Address, post paid, to X, Y, Z, at Mr. Starling's, bookseller, Islington.

TO RAILWAY SURVEYORS. -WANTED, immediately, two or three good RAILWAY SURVEYORS. Liberal terms will be given. Address by letter to O.M., Railway Mail Office, Coleman Street, stating references, &c.

Taken together, Tables 1 and 2 reveal that prior to the Industrial Revolution

a “Pre-Ad” era prevailed with little or no posting by either side of the market, and near the end of the Industrial Revolution a new era emerged in which ads were regularly posted and were more commonly placed by job seekers than by employers (the exception of 1845 notwithstanding). We refer to this period, which lasted throughout the nineteenth century, as the “Early era”. From 1815 to 1905 (and excluding the 1845 anomaly) the average of the entries in Table 2 is 20 percent, so that 4 out of every 5 ads in the newspaper over the course of nearly a century were placed by job seekers rather than by employers. For the period preceding the railway boom, i.e. 1815 to 1835, the average entry in Table 2 suggests that about 88 percent of ads were posted by job seekers. Our model exhibits a type-D equilibrium in which both sides of the market post ads, and a type-E equilibrium (in which employers post but only some workers post) that might match better the later part of the Early era when the fraction of ads posted by job seekers was shrinking. Another possible interpretation of the Early era is that it reflects a blend of type-B and type-C equilibria, with either of these equilibria applying to certain occupations or industries.

Table 2 reveals that the fraction of ads posted by employers jumped from less than 23 percent in 1905 to more than 55 percent in 1915. This appears to be the start of the “Modern era” in which employment-related ads were dominated by employers rather than by job seekers. By 1975 and 1985 the fraction of ads posted by employers exceeded 90 percent, and by the early 1990s the ads were too numerous to count and were posted almost entirely by employers. This situation is well described by the type-B equilibrium from our model, in which all ads are employer posted.

The Modern era ended with the advent of the internet at the end of the twentieth century, which revolutionized employment-related advertising. By the early twenty-first century both employers and job seekers were regularly posting online ads to capitalize on the reduced advertising costs and widened audiences that electronic distribution allows.¹⁹ This era is characterized by the strong resurgence of ads posted by job seekers. In October 2013, on the

¹⁹See Brenčič (2013) for empirical evidence on the number of jobs and the numbers of CVs posted on various online job sites from 2002 to 2012. For example, in 2012 the 100 most popular sites featured about 208,000 jobs and about 2 millions CVs.

Kuhn and Mansour (2011) found that internet job search continues to grow rapidly and that it is now effective and reduces unemployment durations by 25 percent, whereas earlier evidence in Kuhn and Skuterud (2004) and Kroft and Pope (2010) suggested that internet job search was largely ineffective. The increase in online job search has generated growing research interest in the nature of these activities. For example, in a pair of studies of online employer postings on job boards, Brenčič and Norris (2009, 2012) consider the content of online ads and the ways in which employers use these job boards.

homepage of monster.com, the very first link was “Resumes” which allows the user to post a résumé, and the second link was “Jobs” which allows the user to search a database of employment opportunities. This is poignantly reminiscent of how, throughout the Early era, the “Situations Wanted” ads were placed first in the newspaper, followed by a smaller “Help Wanted” section. This fourth and ongoing “Internet era” is well described by our model’s type-D equilibrium.

Figure 1 provides a visual representation of the transition from the Early era to the Modern era by plotting the numbers in Table 2. We begin the plot in 1815 because in 1785 and 1795 there were no ads posted by either side, and in 1805 there were only three ads, which we see as an extension of the Pre-Ad era depicted in Table 1. Figure 1 starts with virtually none of the ads posted by employers and ends with all of the ads posted by employers. However, the dramatic change did not occur overnight. By 1975 the transition was largely completed, but in 1965 the fraction of ads posted by job seekers still exceeded 25 percent. This situation is well described by our type-E equilibrium, in which the employer posts and some (but not all) job seekers post.

The striking trend depicted in Figure 1 is not unique to London. The results of a tour through *The New York Times* appear in Table 3 and Figure 2. We considered the October 24 edition, by decade, from 1851 to 2011. No ads appeared in the 1851 issue, though by October 24 the newspaper had only existed for just over a month, so it might have required some time to establish itself. Figure 2 bears a striking resemblance to Figure 1. Clearly, throughout the latter half of the nineteenth century *The New York Times* was dominated by ads posted by job seekers, whereas by 1991 this situation had flipped, and nearly all ads were posted by employers. As seen in the first few rows of Table 3, in the years 1861, 1871, and 1881 the fraction of employer-posted ads was less than 5 percent. In contrast, by 1991, as was true in London, virtually all ads were employer posted, a situation which is well captured by our equilibrium of type B. The pattern of evidence from Figures 1 and 2 extends beyond London and New York. In fact, we first discovered it in *The San Francisco Chronicle* from 1865 to the present.

To summarize, we have identified four eras in advertising history. The Pre-Ad era, which prevailed through the seventeenth and eighteenth centuries and was brought to an end when the Industrial Revolution reached a climax, was characterized by little or no posting by either side of the labor market. The following Early era, which started in the later part of the Industrial Revolution and extended to the early twentieth century, was characterized by regularly

posted employment-related ads that were dominated by job seekers rather than by employers. The subsequent Modern era featured the decline and ultimately the near extinction of ads posted by job seekers. The fourth and ongoing Internet era coincided with the turn of the twenty-first century and was characterized by a resurgence of ads posted by job seekers, as both sides of the labor market regularly post ads online.

3 A model of advertising and labor market matching

We now develop a theoretical model to explain the evidence in the preceding section. For simplicity, we focus on the case of a single firm, though later we relax this assumption and consider the case of two firms. The model has three stages. In stage 1, N unemployed workers choose whether to post an ad and whether to look for an ad posted by the firm. At the same time the firm, which seeks to hire up to N workers, chooses whether to post an ad and whether to look for ads posted by the workers. If the firm decides to look for ads posted by the workers, it also decides how many ads to read. Denote this number by k . All choices are made simultaneously. Posting an ad costs the firm $c_p > 0$, and looking for an ad costs $c_l > 0$ (per ad). We assume that posting an ad is more costly than looking for a single ad, hence $c_p > c_l$. Since our newspaper evidence spans multiple centuries, illiteracy was widespread in the population of job seekers for much of the timespan we study. We therefore assume that there are two types of workers (literate and illiterate) that differ in their costs of posting and looking for ads. For literate workers these costs are c_p and c_l , whereas for illiterate workers both costs are infinitely high. Thus, illiterate workers never decide to post or to look for ads, and we therefore focus on the decisions of literate workers. We denote the fraction of literate workers by $\beta \in [0, 1]$ and define $n := \beta N$ as the number of literate workers.

In stage 2, if the firm has posted an ad, a worker who is looking for an ad reads (or finds) the posted ad with probability $\alpha \in (0, 1)$, in which case the worker contacts the firm. Similarly, if m workers have posted ads, the firm - if looking for k ads posted by workers - reads each of the posted ads with probability $\min\{1, \frac{k}{m}\} \alpha$. If the firm reads an ad posted by a worker, the firm contacts the worker. The parameter α can be understood in different ways. First, an ad posted by one party may be overlooked by another party. For

example, the ad might be posted in one newspaper while the other party happens to read a different newspaper. Alternatively, one party's ad might appear in the Tuesday edition of the newspaper, whereas the other party bought only the Wednesday edition.²⁰ Second, α may account for impediments to mobility. For example, if a job seeker reads an ad that was posted by a firm, he might not respond to the ad if he faces mobility constraints or feels the firm is located too far away. In all these situations, a worker-firm match is not formed even though one side posts and the other side looks for ads. This possibility is captured by assuming $\alpha < 1$.

If the firm contacts a worker or if a worker contacts the firm, the firm hires the worker in stage 3 and earns a (gross) payoff of $u_F > 0$, and the worker's (gross) payoff from the match is $\hat{u}_W > 0$. A worker's reservation utility, i.e. the payoff that the worker receives if he is not hired by the firm, is denoted by u_0 , where $0 \leq u_0 < \hat{u}_W$. Define $u_W := \hat{u}_W - u_0$.

In summary, a worker i 's strategy is a tuple $(p_{Wi}, l_{Wi}) \in \{0, 1\} \times \{0, 1\}$, where $p_{Wi} = 1$ means that worker i posts an ad, and $l_{Wi} = 1$ means that the worker looks for ads posted by the firm. Similarly, the firm's strategy is a tuple $(p_F, l_F) \in \{0, 1\} \times \{0, \dots, n\}$, where $p_F = 1$ means that the firm posts an ad, and $l_F = k$ means that the firm looks for k ads posted by workers.

We focus on equilibria in pure strategies. If a party is indifferent between a lower and a higher action (for example, if worker i is indifferent between choosing $p_{Wi} = 0$ and $p_{Wi} = 1$), we assume that the party always opts for the higher action (which in the example would be $p_{Wi} = 1$).

We assume that job seekers are free agents, though in the earlier historical periods of our analysis slavery was common. For our analysis, the possibility of slavery does not alter anything fundamental. Like conventional labor, slave labor involves an exchange of money for labor services, and the labor market matching problem is similar for the two types of labor, with two main differences. First, in the context of slavery the payment goes to the worker's current owner rather than to the worker, but from the firm's standpoint it does not really matter who gets the payment. Second, and more importantly, slavery introduces a non-synchronization in revenues and costs in that all wage payments are front loaded in a lump sum payment in exchange for a future stream of "free"

²⁰It is even conceivable that ads posted in a newspaper are overlooked by somebody reading the very same newspaper, in particular when an ad is only one of many in the newspaper. A similar argument may apply to websites such as Monster.com that post a large amount of ads. Here, α may, among other things, depend on whether the website provides a good query/search function to its database.

labor services. This non-synchronization shifts risk onto the employer, which is presumably reflected in the price. A richer, dynamic model incorporating such nuances should leave our main results unchanged, and in any event our present static model with fixed wages permits an interpretation in which some of the job seekers are slaves. As for the data, newspaper ads from both sides of the slave labor market appear in the historical record, though they are not voluminous. Our reading suggests that most ads that concern slaves are posted by owners of runaway slaves with the hope of recovering lost property. This was especially so in the eighteenth-century issues of *The Maryland Gazette* we canvassed.

4 Model solution and comparison of equilibria

Worker i is hired by the firm either if he posts an ad that is read by the firm (event A_i) or if he reads an ad that is posted by the firm (event B_i). The hiring probability is thus given by

$$\begin{aligned} P(A_i \vee B_i) &= P(A_i) + P(B_i) - P(A_i \wedge B_i) \\ &= p_{W_i} \min \left\{ 1, \frac{l_F}{\sum_j p_{W_j}} \right\} \alpha + l_{W_i} p_F \alpha - p_{W_i} \min \left\{ 1, \frac{l_F}{\sum_j p_{W_j}} \right\} l_{W_i} p_F \alpha^2 \\ &= p_{W_i} \min \left\{ 1, \frac{l_F}{\sum_j p_{W_j}} \right\} \alpha (1 - l_{W_i} p_F \alpha) + l_{W_i} p_F \alpha. \end{aligned}$$

Worker i chooses (p_{W_i}, l_{W_i}) to maximize

$$\begin{aligned} U_{W_i} &= P(A_i \vee B_i) \hat{u}_W + (1 - P(A_i \vee B_i)) u_0 - p_{W_i} c_p - l_{W_i} c_l \\ &= u_0 + P(A_i \vee B_i) u_W - p_{W_i} c_p - l_{W_i} c_l. \end{aligned}$$

Similarly, the firm chooses (p_F, l_F) to maximize

$$U_F = \sum_i P(A_i \vee B_i) u_F - p_F c_p - l_F c_l.$$

From the firm's expected payoff function we can derive the following lemma:

Lemma 1 *In equilibrium the firm either chooses $l_F = 0$ or $l_F = \sum_j p_{W_j}$.*

In the following, we consider the two cases $l_F = 0$ and $l_F = \sum_j p_{W_j}$. Suppose

first that $l_F = 0$. Then worker i 's objective becomes

$$U_{W_i} = u_0 + l_{W_i} p_F \alpha u_W - p_{W_i} c_p - l_{W_i} c_l,$$

whereas the firm's expected payoff is

$$U_F = \sum_i l_{W_i} p_F \alpha u_F - p_F c_p.$$

The following proposition characterizes equilibrium behavior.

Proposition 1 *There are two types of equilibria in which the firm chooses $l_F = 0$: (i) An equilibrium in which the firm chooses $(p_F, l_F) = (0, 0)$ and all workers choose $(p_{W_i}, l_{W_i}) = (0, 0)$ always exists. Payoffs are $U_F = 0$ and $U_{W_i} = u_0$. (ii) An equilibrium in which the firm chooses $(p_F, l_F) = (1, 0)$ and each worker chooses $(p_{W_i}, l_{W_i}) = (0, 1)$ exists if and only if $n\alpha u_F - c_p \geq 0$ and $\alpha u_W - c_l \geq 0$. Expected payoffs are $U_F = n\alpha u_F - c_p$ and $U_{W_i} = u_0 + \alpha u_W - c_l$.*

The intuition behind Proposition 1 is simple. If the firm decides neither to post an ad nor to look for worker-posted ads, no workers will be hired. The workers thus minimize their costs by choosing $(p_{W_i}, l_{W_i}) = (0, 0)$. By the same argument, if all workers choose $(p_{W_i}, l_{W_i}) = (0, 0)$, a best response for the firm is $(p_F, l_F) = (0, 0)$. Obviously, as no worker-firm match is formed and no costs are incurred, the firm earns zero profit and each worker receives the reservation utility u_0 .

A more interesting equilibrium is described in the second part of the proposition. Here, the firm and workers coordinate on an equilibrium in which the firm posts an ad and all workers look for ads. Of course, this equilibrium can only exist if posting an ad or looking for ads is not too costly.

Let us now assume that $\sum_j p_{W_j} > 0$ and the firm selects $l_F = \sum_j p_{W_j}$. Suppose in addition that the firm chooses $p_F = 0$, in which case a best response by all workers is $l_{W_i} = 0$ (and *vice versa*). Notice that objective functions of worker i and the firm are then given by

$$U_{W_i} = u_0 + p_{W_i} (\alpha u_W - c_p)$$

and

$$U_F = \sum_j p_{W_j} (\alpha u_F - c_l).$$

From worker i 's objective function it is easy to see that $\sum_j p_{Wj} > 0$ is satisfied if and only if $\alpha u_W - c_p \geq 0$, in which case all workers find it optimal to choose $p_{Wi} = 1$. In turn, the firm is willing to choose $l_F = \sum_j p_{Wj} = n$ if and only if $\alpha u_F - c_l \geq 0$. The following proposition summarizes the results.

Proposition 2 *An equilibrium in which the firm chooses $(p_F, l_F) = (0, n)$ and each worker chooses $(p_{Wi}, l_{Wi}) = (1, 0)$ exists if and only if $\alpha u_F - c_l \geq 0$ and $\alpha u_W - c_p \geq 0$. Expected payoffs are $U_F = n(\alpha u_F - c_l)$ and $U_{Wi} = u_0 + \alpha u_W - c_p$.*

Proposition 2 highlights a different way for the firm and the workers to coordinate. It describes a situation in which all workers post an ad, and the firm looks for ads. Again, this equilibrium can only exist if the costs of posting or reading an ad are not too high.

Finally, equilibria may exist in which $\sum_j p_{Wj} > 0$, $l_F = \sum_j p_{Wj}$, $p_F = 1$ and $l_{Wi} > 0$ for at least one worker i . The firm's objective function could be stated as

$$U_F = \sum_j (p_{Wj}\alpha(1 - l_{Wj}\alpha) + l_{Wj}\alpha) u_F - c_p - \sum_j p_{Wj}c_l,$$

whereas worker i 's expected payoff is

$$U_{Wi} = \begin{cases} u_0 + \alpha(2 - \alpha)u_W - c_p - c_l & \text{if } (p_{Wi}, l_{Wi}) = (1, 1), \\ u_0 + \alpha u_W - c_l & \text{if } (p_{Wi}, l_{Wi}) = (0, 1), \\ u_0 + \alpha u_W - c_p & \text{if } (p_{Wi}, l_{Wi}) = (1, 0), \\ u_0 & \text{if } (p_{Wi}, l_{Wi}) = (0, 0). \end{cases}$$

The following lemmas are helpful for deriving the two remaining equilibria, which are stated in Propositions 3 and 4.

Lemma 2 *In an equilibrium in which the firm chooses $l_F > 0$ and $p_F = 1$, none of the workers finds it optimal to choose $(p_{Wi}, l_{Wi}) = (0, 0)$.*

Lemma 3 *Consider an equilibrium in which the firm chooses $l_F > 0$ and $p_F = 1$. If (at least) one of the workers chooses $(p_{Wi}, l_{Wi}) = (1, 1)$, none of the workers chooses $(p_{Wi}, l_{Wi}) = (1, 0)$.*

Lemma 4 *An equilibrium in which the firm chooses $(p_F, l_F) = (1, k)$ (with $0 < k < n$), k workers choose $(p_{Wi}, l_{Wi}) = (1, 0)$, and $n - k$ workers choose $(p_{Wi}, l_{Wi}) = (0, 1)$ does not exist.*

Proposition 3 *There exists an equilibrium in which the firm chooses $(p_F, l_F) = (1, n)$ and each worker chooses $(p_{W_i}, l_{W_i}) = (1, 1)$ if and only if*

$$\begin{aligned} n\alpha(1-\alpha)u_F - c_p - nc_l &\geq \max\{-c_p, -nc_l\} \text{ and} \\ \alpha(1-\alpha)u_W - c_p &\geq 0. \end{aligned}$$

Expected payoffs are $U_F = n\alpha(2-\alpha)u_F - c_p - nc_l$ and $U_{W_i} = u_0 + \alpha(2-\alpha)u_W - c_p - c_l$.

Proposition 4 *There exists an equilibrium in which the firm chooses $(p_F, l_F) = (1, k)$ (with $0 < k < n$), k workers choose $(p_{W_i}, l_{W_i}) = (1, 1)$, and $n - k$ workers choose $(p_{W_i}, l_{W_i}) = (0, 1)$ if and only if*

$$\begin{aligned} (k\alpha(2-\alpha) + (n-k)\alpha)u_F - c_p - kc_l &\geq \max\{n\alpha u_F - c_p, k(\alpha u_F - c_l)\} \text{ and} \\ \alpha(1-\alpha)u_W &\geq c_p \geq \frac{k}{k+1}\alpha(1-\alpha)u_W. \end{aligned}$$

Expected payoffs are

$$\begin{aligned} U_F &= (k\alpha(2-\alpha) + (n-k)\alpha)u_F - c_p - kc_l \text{ and} \\ U_{w_i} &= \begin{cases} u_0 + \alpha(2-\alpha)u_W - c_p - c_l \text{ if } (p_{W_i}, l_{W_i}) = (1, 1), \\ u_0 + \alpha u_W - c_l \text{ if } (p_{W_i}, l_{W_i}) = (0, 1). \end{cases} \end{aligned}$$

Propositions 3 and 4 demonstrate that equilibria potentially exist in which the firm and some (or all) of the workers decide to post an ad and simultaneously to read ads. Note that existence of these equilibria requires that α not be too high (and c_p and c_l must not be too high either). This is intuitive. Consider a worker who has decided to look for ads and who is considering whether to post an ad. If α is close to 1 the worker can be confident that he will find the ad posted by the firm, so that posting an ad is not worthwhile.

To summarize, we have demonstrated the potential existence of the following five types of equilibria:

$$\begin{aligned}
& (p_F, l_F) = (0, 0), (p_{W_i}, l_{W_i}) = (0, 0) \quad \forall i \text{ (type A)} \\
& (p_F, l_F) = (1, 0), (p_{W_i}, l_{W_i}) = (0, 1) \quad \forall i \text{ (type B)} \\
& (p_F, l_F) = (0, n), (p_{W_i}, l_{W_i}) = (1, 0) \quad \forall i \text{ (type C)} \\
& (p_F, l_F) = (1, n), (p_{W_i}, l_{W_i}) = (1, 1) \quad \forall i \text{ (type D)} \\
& (p_F, l_F) = (1, k) \quad (0 < k < n), (p_{W_i}, l_{W_i}) = (1, 1) \text{ for } k \text{ workers} \\
& \quad (p_{W_i}, l_{W_i}) = (0, 1) \text{ for remaining } n - k \text{ workers} \quad \text{(type E)}
\end{aligned}$$

We now use two criteria to approach the problem of equilibrium selection. First, it is possible that, depending on the parameter constellations, only some equilibria can be sustained. This allows us to focus on the sustainable equilibria, which may even yield a unique prediction regarding equilibrium play. Second, in situations in which there exists more than one equilibrium, we use payoff dominance as a selection criterion whenever possible. This means that if at least two equilibria exist and if one of the equilibria dominates all other equilibria in terms of payoff (i.e. all workers and the firm receive the highest payoff in this equilibrium), we assume that the dominant equilibrium is played. Proposition 5 concerns the existence of equilibria, whereas Proposition 6 refers to payoff dominance.

Proposition 5 (i) *There always exists an equilibrium of type A.*

(ii) *If there exists an equilibrium of type D or E, there also exists an equilibrium of type B and C. The converse is not necessarily true.*

(iii) *Existence of an equilibrium of type B does not imply existence of an equilibrium of type C and vice versa.*

(iv) *Existence of an equilibrium of type D does not imply existence of an equilibrium of type E and vice versa.*

Proposition 6 (i) *Whenever an equilibrium of type other than A exists, this equilibrium payoff dominates the equilibrium of type A.*

(ii) *Suppose that the equilibria of type B and C exist. B payoff dominates C if and only if $c_p \leq nc_l$, whereas C never payoff dominates B.*

(iii) *Whenever the equilibrium of type D exists, D payoff dominates all other equilibria.*

(iv) *Suppose the equilibrium of type E exists. E payoff dominates the equilibrium of type B. E payoff dominates C if and only if $k\alpha(1 - \alpha)u_F + (n - k)c_l \geq c_p$,*

whereas C never payoff dominates E .

5 Welfare implications

In this section we investigate how the welfare of workers and the firm depends on the parameters of our model. Changes in the parameters affect the parties' welfare in two ways. First, conditional on a specific equilibrium being played, changes in the parameters affect workers' and the firm's payoff in this equilibrium. Second, changes in the parameters may induce workers and the firm to behave differently, i.e. to switch to a different equilibrium. Let us begin with the first effect. From the equilibrium payoffs displayed in Propositions 1, 2, 3, and 4 it is straightforward to see that increases in c_p and c_l have a non-positive effect on the payoffs that workers and the firm receive in any equilibrium, whereas increases in u_W , u_F , α and n have a non-negative effect on these payoffs. Moreover, conditional on a particular equilibrium being played, all payoffs are continuous functions of c_p , c_l , u_W , u_F , α and n , i.e. small changes in these parameters have a small impact on payoffs.

We use two examples to illustrate the second effect. Suppose that $c_l = 0$ so that the existence conditions for the equilibria of type B, C and D collapse to $n\alpha u_F - c_p \geq 0$ (B), $\alpha u_W - c_p \geq 0$ (C) and $n\alpha(1 - \alpha)u_F - c_p \geq 0$, $\alpha(1 - \alpha)u_W - c_p \geq 0$ (D), respectively. Moreover, we set $n = 1$ and $u_F = u_W =: u$. Then the equilibria of type B and C can be sustained if and only if $\alpha u \geq c_p$, whereas the equilibrium of type D can be sustained if and only if $\alpha(1 - \alpha)u \geq c_p$. Suppose that initially $c_p \in (\alpha(1 - \alpha)u, \alpha u]$, and let c_p decrease. When c_p becomes lower than $\hat{c}_p := \alpha(1 - \alpha)u$, the worker and the firm switch from an equilibrium of type B or C to the equilibrium of type D. Total welfare then changes from $u_0 + 2\alpha u - c_p$ to $u_0 + 2\alpha(2 - \alpha)u - 2c_p$. The welfare change can be restated as

$$2\alpha(2 - \alpha)u - 2c_p - (2\alpha u - c_p) = 2\alpha(1 - \alpha)u - c_p.$$

Since $2\alpha(1 - \alpha)u - \hat{c}_p = \alpha(1 - \alpha)u > 0$, total welfare is discontinuous at \hat{c}_p . This means that a small decrease in c_p (e.g. by subsidizing the cost of posting an ad) may generate a large increase in welfare. This example is illustrated graphically in Figure 3, assuming $u = 100$ and $\alpha = 0.1$. The graph is discontinuous when the equilibrium switches to D from B or C, and when the equilibrium switches to B or C from A.

A second interesting observation relates to α . Suppose again that $c_l = 0$,

$n = 1$ and $u_F = u_W =: u$. In addition, assume that initially $\alpha \geq 0.5$ and $\alpha(1 - \alpha)u \geq c_p$ so that the worker and firm play the equilibrium of type D. Now suppose that α increases. Since $\alpha(1 - \alpha)u$ is decreasing in α , the condition $\alpha(1 - \alpha)u \geq c_p$ eventually ceases to be met, in which case the worker and firm switch to a different equilibrium in which their payoffs are lower. This implies that although in each of the considered equilibria payoffs are non-decreasing in α , an increase in α may lead to a reduction in total welfare, so that the welfare function is both discontinuous and non-monotonic in α . This discontinuity is illustrated in Figure 4, which assumes $u = 100$, $c_l = 10$, and $c_p = 20$. The figure also reveals two additional points of discontinuity for values of α less than 0.5.

If we return to the general model and assume that the equilibrium switches from D to B, the decrease in welfare is $n[\alpha(1 - \alpha)(u_F + u_W) - (c_p - c_l)]$. This decrease in welfare grows when the investment costs shrink. The type-D equilibrium is the most active one, given that both sides of the market do both activities. From a welfare standpoint, the advantage of this situation is that the positive externalities of these activities are maximized when everyone undertakes them, whereas the disadvantage (which is particularly pronounced when costs are large) is that everyone incurs all costs. Switching from equilibrium D to B (or C) reduces the positive externalities associated with each activity, while also reducing costs because one side of the market free rides on the activity of the other. This reduction in costs is modest when c_p and c_l are low, so that the more important factor driving the welfare change is the reduction in positive externalities, which implies a big drop in welfare when moving from equilibrium D to either B or C. The drop in welfare is also increasing in u_F and u_W because those parameters represent the returns to a match, and a switch from equilibrium D to B (or C) reduces the likelihood of a match. Finally, the drop in welfare is increasing in n .

Collectively, these results concerning α have some interesting and unexpected policy implications. Small labor market interventions to increase job mobility and reduce search frictions – which intuitively would seem to enhance welfare as long as the costs of implementing the policies are modest – can in some cases lead to large reductions in welfare that arise when one side of the labor market is induced to free ride on the investments made by the other side, thereby lowering the positive externalities associated with search-related activities. Such welfare losses are likely to be greater the larger the market (i.e. n), the larger the returns to a match (i.e. u_F and u_W) and the smaller the search-related costs (i.e. c_p and c_l). An implication is that countries may differ in their expected benefits

from policies to increase α . For example, less developed countries (for which u_F and u_W are likely to be low) may face a lower downside risk than developed countries, since any welfare reductions that might arise from a transition from equilibrium D to B (or C) are likely to be modest. Standard economic intuition suggests that in the presence of positive externalities there is underinvestment and that policies to encourage investment can be welfare enhancing. In the present model, policies that hinder job mobility and increase search frictions can be welfare enhancing in some cases if they sufficiently weaken the incentive of one side of the market to free ride on the investments of the other. The positive externalities resulting from the additional investments may outweigh the negative effect on welfare of the reduction in job mobility and increase in search frictions. Consider two alternative ways a policymaker could intervene. One is to increase α , and the other is to decrease c_p and/or c_l . Abstracting from the costs of the alternative policies, our analysis suggests that the latter may be the better choice for two reasons. First, if the economy is in equilibria B or C, a reduction in search costs increases welfare continuously but may also induce a sharp increase in welfare if the economy enters equilibrium D. Second, if the economy is already in equilibrium D, a reduction in search costs increases welfare continuously but without the risk of tipping the economy into the inferior equilibria B or C involving free riding.

6 Explaining the historical evolution of job advertisements

Before applying our model to propose possible explanations for the historical evolution of advertising behavior documented in Section 2, we address some alternative explanations that were suggested to us by others. One common reaction to the pattern of evidence in Figures 1 and 2 is that it might be explained by changes in the relative bargaining power of workers and firms over time, caused either by institutions (e.g. the abolition of slavery or the introduction and growth of unions) or by market forces (i.e. shifts in supply and demand for labor). In the context of our model, changes in relative bargaining power can be interpreted as changes in the relative values of u_F and u_W . We feel that explanations based on slavery or unions can be eliminated based on

timing.²¹

Market forces that shift the demand and supply of labor can also be a reason for a changing balance of bargaining power between workers and firms. Perhaps when there are relatively few vacancies (job seekers) it is the job seekers (employers) who need to invest in persuasion. Our argument that the 1845 spike in Figure 1 can be attributed to the railway boom in London is consistent with labor market tightness affecting posting behavior. However, this cannot be the only (or even the main) explanation for the pattern of evidence, for at least two reasons. First, the changes in relative bargaining power resulting from shifts in labor supply and demand are cyclical. In contrast, the graphs in Figures 1 and 2 are marching steadily upward over the entire period. There has not been a dramatic, monotonic change in the supply and demand for labor over the span of more than a century, in either the United States or Britain.²² Second, if the explanation for Figures 1 and 2 is changes in supply and demand, the impact of the Great Depression (the most severe instance of excess labor supply in the twentieth century) should be clearly visible in posting behavior. In the United States the start of the Great Depression is typically defined to coincide with the stock market collapse in October 1929. The 1931 observation in Figure 2 occurred a full two years into the Great Depression, and there is no indication that the sharp increase in unemployment led to an increase in the fraction of ads posted by job seekers. A similar argument can be made for Britain. Furthermore, Katz and Margo (2013) cite new archival wage data suggesting that the demand for high-skilled, white collar workers grew more rapidly than supply for a period long pre-dating the Civil War and extending to the end of the nineteenth century, though the first few observations of Figure 2 do not suggest a concomitant sharp increase in the share of ads posted by employers.

Although we think it is clear that supply and demand shifts cannot explain

²¹In the United States, the Emancipation Proclamation was signed in 1863, and the thirteenth amendment (abolishing slavery) was passed in 1865. But Figure 2 shows that the fraction of ads posted by employers was well under ten percent even as late as 1881. In Britain, the British Slavery Abolition Act came into force in 1834. At the time, the fraction of ads posted by employers was around ten percent. Figure 1 reveals a sharp and temporary uptick in the fraction shortly after that, but we have argued that this is likely due to the railway boom in London in the mid 1840s. In both Figures 1 and 2, all but the first few observations succeed the abolition of slavery. Similarly, union density in the United States increased until around the Second World War, peaking shortly after the war and then starting a pronounced and continuous decline. Such a trajectory could not explain Figure 2, and a similar argument can be made for Britain.

²²For example, the U.S. unemployment rate was 4.3 percent in 1901 and 9.5 percent in 1911, whereas a century later it was 5.3 percent in 2001 and 8.9 percent in 2011. The first two numbers are yearly estimates from Lebergott (1957), and the latter two are from October BLS data.

the bulk of Figures 1 and 2, these forces seem to have played a role in 1845 in London. The question is why employers temporarily deviated from their usual behavior during the railway boom. One possibility is that the boom created a sudden and unexpected demand for a certain type of labor requiring specialized skills that are not acquired overnight (e.g. jobs as engineers or surveyors) and for which no ready substitutes are available. This situation would create a shortage of the type not often seen in the labor market. Under these circumstances, many job seekers posting ads would receive multiple contacts from prospective employers, and in turn employers would frequently find that responding to a job seeker's posting would not lead to a match. Employers for whom the returns to filling a vacancy were highest might also find it in their interests to post ads offering generous compensation (as in the examples we presented) so as to favorably distinguish themselves from competing employers. Note that the same type of reasoning would likely not apply in the case of excess labor supply. That is, a job seeker posting a willingness to accept very low wages might send a negative rather than a positive signal to prospective employers who might fear adverse selection.

Another suggestion is that the pattern of evidence in Figures 1 and 2 could be driven by technological progress that changed the nature of jobs. This might have influenced the relative importance of information about one side of the labor market versus the other, potentially changing the relative returns to posting ads. The importance of finding a high-quality match (as opposed to simply a match) might have changed due to technological progress, resulting in a change in which side of the market invested in advertising.

Our reaction to this argument is that even if a change in the returns to match quality occurred during the years covered in Figures 1 and 2, it is not obvious why that should have implications for which side of the labor market posts. Ads can be short and general or long and detailed, regardless of which side posts, and both types of ads can be found from either side of the labor market, both in the late nineteenth and late twentieth centuries. The most typical case, in either time period, is a brief ad, regardless of who posts it. Consider the following ad posted in the October 24, 1861 edition of *The New York Times* by a male job seeker: "AS BOOK-KEEPER. - WANTED, A SITUATION, by a thoroughly competent double-entry book-keeper of thirteen years' practical experience; was five years with last employers. Good City reference furnished. Address WM. CHAPMAN, Powers' Hotel." Compare that ad to the following employer-posted ad appearing in the October 24, 2001 edition of the same news-

paper: “BOOKKEEPER F/C. For sml, prestigious mdtn office. Must have 3+ years exp MAS 90. Sal negot. FAX resume 212-752-5082.” Apart from the fact that the accounting software MAS 90 was not available in 1861, we see little difference between these ads except for which side of the labor market posted them. And the technological progress embodied in the accounting software does not seem crucial from the standpoint of which side of the labor market posts. If the software had been available in 1861, we expect that the job seeker would have mentioned his experience with it in his ad.²³ Overall, our reading of the newspapers suggests that there has been no dramatic historical shift (as measured by the nature and content of the postings) in the returns to match quality during the period covered in Figures 1 and 2, and although technology changed the nature and composition of jobs in the economy, it is unclear why this should have had a dramatic impact on which side of the labor market posts ads.

Turning to our model, the Pre-Ad era covered in Table 1 and the first three rows of Table 2 is best described by our model’s equilibrium of type A. Although posts were occasionally seen during this period on either side of the market, they were quite rare. What followed was an era of regularly posted ads, dominated by worker-posted ads, that lasted roughly throughout the nineteenth century. Recall from Table 3 that the average fraction of ads posted by New York City employers was less than 5 percent in the years 1861, 1871, and 1881. Keeping in mind that the number of workers that are looking for a job exceeds the number of firms that hire workers, our type-D equilibrium can be thought of as an approximation to this situation. As noted earlier, another possibility is that equilibria of types B and C occur simultaneously, implying that the structure of the game resembles that of “battle of the sexes”. The observed behavior could then be explained in two ways: either some people failed to coordinate on the correct equilibrium or some occupations and industries played equilibrium B whereas others played C. We now turn to a potential explanation for the shift from the Pre-Ad era characterized by the type-A equilibrium to the Early era characterized by the type-D equilibrium (or the joint occurrence of equilibria of type B and C). Our impression is that the timing of this transition suggests that it arose from increases in literacy rates (driven by the Industrial Revolution and

²³Our book keepers example focuses on a job that existed in both time periods. It is true that technological progress changed the composition of jobs in the economy as well as the nature of particular jobs. For example, there are no ads for coachmen in the late twentieth century, whereas there are many in the 1860s. But there are modern counterparts to most jobs (e.g. the coachmen of the nineteenth century are the bus, cab, and limousine drivers of the twentieth century), so similar arguments can be made.

the growth of public schools).

As Tables 1 and 2 reveal, the type-A equilibrium clearly prevailed around 1760 at the start of the Industrial Revolution, whereas by the end of the Industrial Revolution the new era of regularly posted ads was emerging. The technological innovations of the Industrial Revolution brought new manufacturing processes that lowered the production costs of paper, books, and other printed materials, making them more affordable for all social classes. These changes facilitated improvements in literacy rates.²⁴ In the context of our model, a situation in which most of the economic agents are illiterate can be thought of as one in which β is extremely low. In the extreme case, β is equal to zero which means that all people that are out of work and looking for a job are illiterate. Obviously, posting an ad or looking for ads is neither optimal for the firm nor for the workers in this situation, so that the type-A equilibrium prevails. When literacy expanded (because of the Industrial Revolution), the costs of posting and reading ads dropped substantially for the workers who became literate. As a consequence, it is conceivable that the type-C equilibrium emerged, with workers demonstrating their newly acquired skills by posting ads and firms looking for these worker-posted ads.

Further promulgating literacy, in New York City the education system became public in every respect when the schools of the Public School Society were turned over to the city's first Board of Education (established in 1842), propelling the system in both growth and effectiveness for the remainder of the century (Palmer 1905). By 1904 the city's system had 546 school buildings, more than 13,000 teachers, a growing registration of 622,000 students, and national recognition for quality (Palmer 1905).²⁵ In London, the Newcastle Report of 1861 urged the provision of "sound and cheap" elementary schools for working class children between the ages of 5 and 13, and in 1870 Parliament passed the Elementary Education Act (The Forster Act) to implement those recommendations (Gillard 2009).

²⁴As noted in West (1978), "It is generally agreed by all participants that people were more literate at the end of the Industrial Revolution period, 1760-1840, than they were at the beginning." See also Figure 1 of that study, which documents a sharp decrease in the annual percentage of males and females unable to sign at marriage, in England and Wales from 1839 to 1912, and Figure 2, which documents a sharp decrease in the annual percentages of illiterate male and female school leavers (as determined by their inability to sign the marriage register 15 years later) from 1820 to 1900.

²⁵In 1904 New York City's schools won multiple gold medals at the Louisiana Purchase Exposition in Missouri, and in the same year Harvard's president (Charles William Eliot) stated that "New York City has produced a system of public instruction which the whole country may well copy." (Palmer 1905)

A similar argument to the preceding can explain the transition from the Modern era to the Internet era that occurred in the late twentieth and early twenty-first centuries. The advent of the internet led to a significant decrease in the costs of posting and reading ads.²⁶ This led to a transition from the type-B equilibrium in which employers posted ads to a type-D (or type-E) equilibrium in which both firms and job seekers posted (online) ads. In the context of our model, the decrease in posting cost implies $c_p \leq \alpha(1 - \alpha) \min\{u_W, u_F\}$, where in the Modern era this inequality was reversed. This switching of the inequality allows the type-D equilibrium to be sustainable. As noted earlier, the type-D equilibrium dominates all other equilibria with respect to payoff and is therefore selected. Hence, we observe both firms and workers posting ads. In the following subsections we propose three complementary explanations for the transition from the Early era to the Modern era.

6.1 Size of firms

As Figure 2 in Poschke (2011) shows for the US, firms have grown in size over time, and the biggest growth seems to have occurred between 1940 and 1980. This simple observation has the potential to explain the historical change in advertising behavior. In our model, an increase in firm size can be captured by an increase in N , which causes an increase in n . First consider the Early era. Suppose that $c_l < c_p \leq \alpha \min\{u_W, u_F\}$, but $c_p > \alpha(1 - \alpha)u_W$ and $c_p > nc_l$. Then only the equilibria of type A, B and C exist.²⁷ The equilibrium of type A is dominated with respect to payoff and is therefore never selected. The equilibria of types B and C do not dominate each other and can both be selected.²⁸ Therefore, we sometimes observe firms posting ads and sometimes workers posting ads. Next consider the Modern era, and note that the growth in firm size over time means that now $c_p \leq nc_l$. In this case the equilibrium of type B dominates the equilibrium of type C with respect to payoff, so that the latter equilibrium is no longer played. Intuitively, if n increases, the firm gets

²⁶Lower costs have also facilitated greater detail in the content of employment-related postings, company and personal websites, and Facebook pages. Brenčić and Norris (2009) find that the average length of an online job description is about 2553 characters long (about one page), which significantly exceeds the length of the typical job ad that was printed historically in the newspaper.

²⁷To see that the equilibria of type D and E do not exist, note that $c_p > \alpha(1 - \alpha)u_W$ is equivalent to $\alpha u_W - c_l > \alpha(2 - \alpha)u_W - c_p - c_l$. Hence, the condition $\alpha(2 - \alpha)u_W - c_p - c_l \geq \max\{\alpha u_W - c_p, \alpha u_W - c_l, 0\}$ is not fulfilled.

²⁸We found that a mixed-strategy equilibrium in which all workers mix between $(p_{Wi}, l_{Wi}) = (0, 1)$ and $(p_{Wi}, l_{Wi}) = (1, 0)$ and the firm mixes between $(p_F, l_F) = (0, n)$ and $(p_F, l_F) = (1, 0)$ does not exist, and a proof is available upon request.

overwhelmed by a large number of worker ads to read. The firm and all workers then maximize their payoffs when the firm posts an ad and workers read this ad. Therefore, we only observe firms posting ads, as was true in London and New York in the early 1990s, as seen in Figures 1 and 2.

6.2 Job mobility and search frictions

Search frictions and impediments to worker mobility have decreased over time, due to the increasing dissemination of information and to a reduction in transportation costs. In the context of our model, a reduction in search frictions implies an increase in α . Such a change could explain the historical evolution of advertising behavior. First, consider the Early era, and suppose that $c_p \leq \alpha(1 - \alpha) \min\{u_W, u_F\}$, $c_p < nc_l$ and $\alpha > 0.5$. In this case the equilibrium of type D exists and is selected, so that we observe both firms and workers posting ads. Next consider the Modern era. The increase in α over time implies that the condition $c_p \leq \alpha(1 - \alpha) \min\{u_W, u_F\}$ is violated (note that $\frac{\partial \alpha(1 - \alpha)}{\partial \alpha} = 1 - 2\alpha < 0$ if $\alpha > 0.5$; note also that $c_p \leq \alpha \min\{u_W, u_F\}$ continues to hold, since $\frac{\partial \alpha \min\{u_W, u_F\}}{\partial \alpha} > 0$). Accordingly, the equilibrium of type D no longer exists. As described in Section 5, the intuition for a worker who expects the firm to post and read ads is as follows:²⁹ By posting and reading ads instead of simply reading ads, the worker increases the probability of being hired from α to $2\alpha - \alpha^2$ but also incurs the cost of posting an ad. If α is relatively high, the probability difference $2\alpha - \alpha^2 - \alpha = \alpha(1 - \alpha)$ is low, so that the worker is not willing to incur the cost of posting an ad. However, the equilibria of types B and C (in which only one market side posts ads) exist. Because $c_p < nc_l$ the equilibrium of type B dominates the equilibrium of type C with respect to payoff, so that the former equilibrium is played. We therefore observe only firms posting ads in the late twentieth century.

6.3 Incremental gain from being hired

It is likely that the difference in utility from being hired by a firm versus being unemployed has decreased over time. This is because around the turn of the twentieth century the absence of social security systems meant that unemployment imposed particularly high costs on workers. As the twentieth century progressed and social security systems developed (e.g. the New Deal policies of

²⁹ A similar argument applies to a firm that expects workers to post and read ads.

the US in the 1930s), the costs of being unemployed diminished. In the context of the model, this implies that u_0 became higher and, as a consequence, u_W became lower between the Early and Modern eras. This can explain the historical shift in the pattern of job advertisements. First, consider the Early era, and suppose that $c_p \leq \alpha(1 - \alpha) \min\{u_W, u_F\}$ and $c_p < nc_l$. Then the equilibrium of type D exists and is selected, so that we observe both firms and workers posting ads. Next consider the Modern era. Compared with the Early era, u_W has decreased over time so that $c_p \leq \alpha(1 - \alpha)u_W$ and even $c_p \leq \alpha u_W$ are now violated. Accordingly, the equilibria of types C and D no longer exist. Intuitively, because of the development of social security systems and the resulting decrease in u_W , workers are no longer willing to incur the cost of posting an ad to find employment. The equilibrium of type B, however, exists and is played. Therefore, we only observe firms posting ads in the late twentieth century.

7 Multiple Employers

Thus far, we have made the simplifying assumption that there is only one firm in the market. With more than one firm the analysis becomes complex because of a proliferation of potential equilibria. In this section, we consider the case of 2 firms (indexed by $j = 1, 2$) and demonstrate that equilibria exist which have very similar properties to those from Section 4.

We assume that if both firms read an ad posted by a worker, each firm hires the worker with probability 0.5. Furthermore, if the worker chooses $l_{Wi} = 1$ and if both of the firms have posted an ad, the worker finds one of the posted ads with probability $1 - (1 - \alpha)^2 = \alpha(2 - \alpha)$, in which case the worker stops looking for a second ad. The worker finds each of the posted ads with the same probability.

Using similar arguments as in the basic model, we can derive the following four propositions:

Proposition 7 *An equilibrium in which each firm chooses $(p_{Fj}, l_{Fj}) = (0, 0)$ and each worker chooses $(p_{Wi}, l_{Wi}) = (0, 0)$ always exists. Payoffs are $U_{Fj} = 0$ and $U_{Wi} = u_0$.*

Proposition 8 *An equilibrium in which each firm chooses $(p_{Fj}, l_{Fj}) = (1, 0)$ and each worker chooses $(p_{Wi}, l_{Wi}) = (0, 1)$ exists if and only if $0.5\alpha(2 - \alpha)nu_F - c_p \geq 0$ and $\alpha(2 - \alpha)u_W - c_l \geq 0$. Expected payoffs are $U_{Fj} = 0.5\alpha(2 - \alpha)nu_F - c_p$ and $U_{Wi} = u_0 + \alpha(2 - \alpha)u_W - c_l$.*

Proposition 9 *An equilibrium in which each firm chooses $(p_{Fj}, l_{Fj}) = (0, n)$ and each worker chooses $(p_{Wi}, l_{Wi}) = (1, 0)$ exists if and only if $0.5\alpha(2 - \alpha)u_F - c_l \geq 0$ and $\alpha(2 - \alpha)u_W - c_p \geq 0$. Expected payoffs are $U_{Fj} = n(0.5\alpha(2 - \alpha)u_F - c_l)$ and $U_{Wi} = u_0 + \alpha(2 - \alpha)u_W - c_p$.*

Proposition 10 *An equilibrium in which each firm chooses $(p_{Fj}, l_{Fj}) = (1, n)$ and each worker chooses $(p_{Wi}, l_{Wi}) = (1, 1)$ exists if and only if*

$$0.5 \left(1 - (1 - \alpha)^4\right) nu_F - c_p - nc_l \geq \max \left\{ 0.5\alpha \left(1 + (1 - \alpha)^2\right) nu_F - c_p, 0.5\alpha \left(1 + (1 - \alpha)^2\right) nu_F - nc_l, 0 \right\}$$

and

$$\left(1 - (1 - \alpha)^4\right) u_W - c_p - c_l \geq \max \{ \alpha(2 - \alpha)u_W - c_p, \alpha(2 - \alpha)u_W - c_l, 0 \}.$$

Expected payoffs are $U_{Fj} = 0.5 \left(1 - (1 - \alpha)^4\right) nu_F - c_p - nc_l$ and $U_{Wi} = u_0 + \left(1 - (1 - \alpha)^4\right) u_W - c_p - c_l$.

The four equilibria outlined in Propositions 7 to 10 possess properties similar to those of the corresponding equilibria from the basic model with one firm. First, it is immediate that the equilibrium described in Proposition 7 is payoff dominated by any of the three other equilibria whenever such an alternative equilibrium exists. Second, the equilibrium described in Proposition 8 payoff dominates the equilibrium from Proposition 9 if $c_p < nc_l$. In addition, for sufficiently small c_p and c_l the equilibrium described in Proposition 10 payoff dominates the three preceding equilibria. Therefore the arguments from Section 6 are likely to apply in the case of two competing firms.

8 Concluding Remarks

To understand the four eras of advertising history and the transitions across them, we developed a theoretical framework emphasizing strategic interactions in the search-related investments of job seekers and employers. A direct consequence of accounting for strategic behavior is discontinuity and non-monotonicity in the social welfare function, which has a number of potentially important policy implications, some of which we have highlighted. Our model shows that small policy changes can have large effects on welfare and that the predicted

effect of a policy change depends on which side of the labor market invests in search-related activities. Seemingly innocuous policies like those aimed at increasing job mobility and reducing search frictions can have the unintended consequence of inducing one side of the market to free ride on the investments of the other, thereby reducing positive externalities and welfare. Alternative policy interventions aimed at reducing search-related costs are not subject to those risks.

The analysis illustrates how history can deepen our understanding of the functioning of labor markets. Dramatic changes in the search-related activities of employers and job seekers have occurred over time, permitting illuminating inquiry into the reasons for those changes. But these patterns of evidence emerged only when the historical clock was turned back a considerable time, unveiling secrets buried in a stack of old newspapers.

Appendix

Proof of Lemma 1. It is straightforward to see that the firm never chooses l_F higher than $\sum_j p_{Wj}$, because starting from $l_F = \sum_j p_{Wj}$, the marginal return to the firm from increasing l_F is zero (since $\min\left\{1, \frac{l_F}{\sum_j p_{Wj}}\right\} = 1$ for $l_F = \sum_j p_{Wj}$), whereas the marginal cost is strictly positive. Hence, we can rewrite $\min\left\{1, \frac{l_F}{\sum_j p_{Wj}}\right\}$ as $\frac{l_F}{\sum_j p_{Wj}}$, and the firm's objective function becomes

$$\begin{aligned} U_F &= \sum_i \left(p_{Wi} \frac{l_F}{\sum_j p_{Wj}} \alpha (1 - l_{Wi} p_F \alpha) + l_{Wi} p_F \alpha \right) u_F - p_F c_p - l_F c_l \\ &= \left(\frac{l_F}{\sum_j p_{Wj}} \sum_i p_{Wi} \alpha (1 - l_{Wi} p_F \alpha) + \sum_i l_{Wi} p_F \alpha \right) u_F - p_F c_p - l_F c_l. \end{aligned}$$

As the function is linear in l_F , it is maximized either at $l_F = 0$ or at $l_F = \sum_j p_{Wj}$. ■

Proof of Proposition 1. If the firm chooses $l_F = 0$, a best response by each worker is to choose $p_{Wi} = 0$. Similarly, if each worker chooses $p_{Wi} = 0$, a best response by the firm is to choose $l_F = 0$. Then each worker's expected payoff simplifies to $U_{Wi} = u_0 + l_{Wi} (p_F \alpha u_W - c_l)$. It immediately follows that each worker chooses the same l_{Wi} (either $l_{Wi} = 1$ if $p_F \alpha u_W - c_l \geq 0$ or $l_{Wi} = 0$ if $p_F \alpha u_W - c_l < 0$). Four possibilities for the equilibrium strategy profile remain, (i) $(p_F, l_F) = (p_{Wi}, l_{Wi}) = (0, 0)$, (ii) $(p_F, l_F) = (1, 0)$ and $(p_{Wi}, l_{Wi}) = (0, 1)$, (iii) $(p_F, l_F) = (0, 0)$ and $(p_{Wi}, l_{Wi}) = (0, 1)$, (iv) $(p_F, l_F) = (1, 0)$ and $(p_{Wi}, l_{Wi}) = (0, 0)$. It is straightforward to see that possibilities (iii) and (iv) cannot occur in equilibrium, because in (iii) each worker would want to deviate to $(p_{Wi}, l_{Wi}) = (0, 0)$, whereas in (iv) the firm would want to deviate to $(p_F, l_F) = (0, 0)$. On the contrary, $(p_F, l_F) = (0, 0)$ and $(p_{Wi}, l_{Wi}) = (0, 0)$ represent mutually best responses so that the strategy profile in (i) constitutes an equilibrium. Obviously expected payoff for the firm is zero, whereas workers receive u_0 . Consider now the strategy profile in (ii). The only profitable deviation for the firm could be to $(p_F, l_F) = (0, 0)$. The firm does not want to deviate if and only if $n \alpha u_F - c_p \geq 0$. Similarly, the only profitable deviation for worker i could be to $(p_{Wi}, l_{Wi}) = (0, 0)$. Worker i does not want to deviate if and only if $\alpha u_W - c_l \geq 0$. ■

Proof of Lemma 2. The firm chooses $p_F = 1$ only if at least one of the workers chooses $l_{Wi} = 1$. This requires $\alpha u_W - c_l \geq 0$, in which case each worker

prefers to choose $(p_{Wi}, l_{Wi}) = (0, 1)$ rather than $(p_{Wi}, l_{Wi}) = (0, 0)$. ■

Proof of Lemma 3. If a worker chooses $(p_{Wi}, l_{Wi}) = (1, 1)$, he does not want to deviate to $(p_{Wi}, l_{Wi}) = (1, 0)$. This means that $\alpha(2 - \alpha)u_W - c_p - c_l \geq \alpha u_W - c_p$, in which case each worker would prefer to choose $(p_{Wi}, l_{Wi}) = (1, 1)$ rather than $(p_{Wi}, l_{Wi}) = (1, 0)$. ■

Proof of Lemma 4. A worker who chooses $(p_{Wi}, l_{Wi}) = (1, 0)$ would want to deviate to $(p_{Wi}, l_{Wi}) = (0, 1)$ iff $\alpha u_W - c_p < \alpha u_W - c_l$. Because $c_l < c_p$, this condition is obviously met. ■

Proof of Proposition 3. It is easy to see that the firm's expected payoff in equilibrium is

$$U_F = n\alpha(2 - \alpha)u_F - c_p - nc_l.$$

If the firm were to deviate to $(p_F, l_F) = (1, 0)$, this payoff would become

$$n\alpha u_F - c_p.$$

Similarly, in case of a deviation to $(p_F, l_F) = (0, n)$ or $(p_F, l_F) = (0, 0)$, the firm's payoff would change to $n(\alpha u_F - c_l)$ or zero, respectively. Hence, the firm does not deviate from $(p_F, l_F) = (1, n)$ if and only if

$$n\alpha(2 - \alpha)u_F - c_p - nc_l \geq \max\{n\alpha u_F - c_p, n(\alpha u_F - c_l), 0\}.$$

$$n\alpha(2 - \alpha)u_F - c_p - nc_l \geq n\alpha u_F - c_p$$

is equivalent to

$$\alpha(1 - \alpha)u_F - c_l \geq 0,$$

implying $\alpha u_F - c_l \geq 0$. Hence, the existence condition can be restated as

$$n\alpha(2 - \alpha)u_F - c_p - nc_l \geq \max\{n\alpha u_F - c_p, n(\alpha u_F - c_l)\}$$

or equivalently as

$$n\alpha(1 - \alpha)u_F - c_p - nc_l \geq \max\{-c_p, -nc_l\}.$$

Again, it is straightforward to verify that worker i 's equilibrium payoff is

$$U_{Wi} = u_0 + \alpha(2 - \alpha)u_W - c_p - c_l.$$

If worker i were to deviate to $(p_{Wi}, l_{Wi}) = (1, 0)$, $(p_{Wi}, l_{Wi}) = (0, 1)$ or $(p_{Wi}, l_{Wi}) = (0, 0)$, his payoff would become $u_0 + \alpha u_W - c_p$, $u_0 + \alpha u_W - c_l$ or u_0 , respectively. Hence, worker i does not want to deviate from the proposed equilibrium if and only if

$$\alpha(2 - \alpha)u_W - c_p - c_l \geq \max\{\alpha u_W - c_p, \alpha u_W - c_l, 0\}.$$

Since $c_l < c_p$, we obtain $\max\{\alpha u_W - c_p, \alpha u_W - c_l, 0\} = \max\{\alpha u_W - c_l, 0\}$. Moreover,

$$\alpha(2 - \alpha)u_W - c_p - c_l \geq \alpha u_W - c_l$$

is equivalent to

$$\alpha(1 - \alpha)u_W - c_p \geq 0,$$

implying $\alpha u_W - c_l > 0$. Accordingly, the existence condition simplifies to

$$\alpha(2 - \alpha)u_W - c_p - c_l \geq \alpha u_W - c_l \Leftrightarrow \alpha(1 - \alpha)u_W - c_p \geq 0.$$

■

Proof of Proposition 4. It is easy to see that the firm's expected payoff in equilibrium is

$$U_F = (k\alpha(2 - \alpha) + (n - k)\alpha)u_F - c_p - kc_l.$$

If the firm were to deviate to $(p_F, l_F) = (1, 0)$, this payoff would become

$$n\alpha u_F - c_p.$$

Similarly, in case of a deviation to $(p_F, l_F) = (0, k)$ or $(p_F, l_F) = (0, 0)$, the firm's payoff would change to $k(\alpha u_F - c_l)$ or zero, respectively. Hence, the firm does not deviate from $(p_F, l_F) = (1, k)$ if and only if

$$(k\alpha(2 - \alpha) + (n - k)\alpha)u_F - c_p - kc_l \geq \max\{n\alpha u_F - c_p, k(\alpha u_F - c_l), 0\}.$$

Notice that

$$(k\alpha(2 - \alpha) + (n - k)\alpha)u_F - c_p - kc_l \geq n\alpha u_F - c_p$$

is equivalent to

$$\alpha(1 - \alpha)u_F - c_l \geq 0,$$

implying $k(\alpha u_F - c_l) \geq 0$. Hence, the existence condition simplifies to

$$(k\alpha(2 - \alpha) + (n - k)\alpha)u_F - c_p - kc_l \geq \max\{n\alpha u_F - c_p, k(\alpha u_F - c_l)\}.$$

Furthermore, it is straightforward to verify that worker i 's equilibrium payoff is

$$U_{W_i} = \begin{cases} u_0 + \alpha(2 - \alpha)u_W - c_p - c_l & \text{if } (p_{W_i}, l_{W_i}) = (1, 1), \\ u_0 + \alpha u_W - c_l & \text{if } (p_{W_i}, l_{W_i}) = (0, 1). \end{cases}$$

Consider a worker i who chooses $(p_{W_i}, l_{W_i}) = (1, 1)$. If this worker were to deviate to $(p_{W_i}, l_{W_i}) = (1, 0)$, $(p_{W_i}, l_{W_i}) = (0, 1)$ or $(p_{W_i}, l_{W_i}) = (0, 0)$, his payoff would become $u_0 + \alpha u_W - c_p$, $u_0 + \alpha u_W - c_l$ or u_0 , respectively. Hence, worker i does not want to deviate from the proposed equilibrium if and only if

$$\alpha(2 - \alpha)u_W - c_p - c_l \geq \max\{\alpha u_W - c_p, \alpha u_W - c_l, 0\}.$$

As demonstrated in the proof of Proposition 3, this condition simplifies to $\alpha(1 - \alpha)u_W \geq c_p$. Finally, consider a worker i who chooses $(p_{W_i}, l_{W_i}) = (0, 1)$. If this worker were to deviate to $(p_{W_i}, l_{W_i}) = (1, 0)$, $(p_{W_i}, l_{W_i}) = (1, 1)$ or $(p_{W_i}, l_{W_i}) = (0, 0)$, his payoff would become $u_0 + \frac{k}{k+1}\alpha u_W - c_p$, $u_0 + \left(\frac{k}{k+1}\alpha(1 - \alpha) + \alpha\right)u_W - c_p - c_l$ or u_0 , respectively. Hence, worker i does not want to deviate from the proposed equilibrium if and only if

$$\alpha u_W - c_l \geq \max\left\{\frac{k}{k+1}\alpha u_W - c_p, \left(\frac{k}{k+1}\alpha(1 - \alpha) + \alpha\right)u_W - c_p - c_l, 0\right\}.$$

$\alpha u_W - c_l$ always exceeds $\frac{k}{k+1}\alpha u_W - c_p$, and because of $\alpha(1 - \alpha)u_W \geq c_p$ it is also strictly positive. Therefore, the condition can be restated as

$$\alpha u_W - c_l \geq \left(\frac{k}{k+1}\alpha(1 - \alpha) + \alpha\right)u_W - c_p - c_l \Leftrightarrow c_p \geq \frac{k}{k+1}\alpha(1 - \alpha)u_W.$$

■

Proof of Proposition 5. (i) See Proposition 1. (ii) Suppose there exists an equilibrium of type D or E. Then, it must be that

$$\begin{aligned} \alpha(2 - \alpha)u_W - c_p - c_l &\geq \max\{\alpha u_W - c_p, \alpha u_W - c_l, 0\} \text{ and} \\ n\alpha(2 - \alpha)u_F - c_p - nc_l &\geq \max\{n\alpha u_F - c_p, n(\alpha u_F - c_l), 0\} \text{ or} \end{aligned}$$

$$k\alpha(2 - \alpha)u_F + (n - k)\alpha u_F - c_p - kc_l \geq \max\{n\alpha u_F - c_p, k(\alpha u_F - c_l), 0\}.$$

From the first condition we see that $\alpha(2-\alpha)u_W - c_p - c_l \geq \alpha u_W - c_p \Rightarrow \alpha u_W - c_l \geq \alpha(1-\alpha)u_W - c_l \geq 0$ and $\alpha(2-\alpha)u_W - c_p - c_l \geq \alpha u_W - c_l \Rightarrow \alpha u_W - c_p \geq \alpha(1-\alpha)u_W - c_p \geq 0$. Similarly, both $n\alpha(2-\alpha)u_F - c_p - nc_l \geq n\alpha u_F - c_p$ and $(k\alpha(2-\alpha) + (n-k)\alpha)u_F - c_p - kc_l \geq n\alpha u_F - c_p$ imply $\alpha(1-\alpha)u_F - c_l \geq \alpha(1-\alpha)u_F - c_l \geq 0$. Moreover both $n\alpha(2-\alpha)u_F - c_p - nc_l \geq n(\alpha u_F - c_l)$ and $(k\alpha(2-\alpha) + (n-k)\alpha)u_F - c_p - kc_l \geq k(\alpha u_F - c_l)$ imply $n\alpha u_F - c_p \geq 0$. We therefore see that the respective existence conditions for the equilibria of type B and C must be fulfilled. Finally, it is straightforward to give an example for which the existence conditions for the equilibria of types B and C are fulfilled, whereas those for the equilibria of types D and E are violated.

(iii) Even if $n\alpha u_F - c_p \geq 0$ and $\alpha u_W - c_l \geq 0$ (so that the equilibrium of type B exists), it is conceivable that $c_p > \alpha u_W$ (so that the equilibrium of type C does not exist). Similarly, even if $\alpha u_F - c_l \geq 0$ and $\alpha u_W - c_p \geq 0$ (so that C exists), it is conceivable that $c_p > n\alpha u_F$ (so that B does not exist).

(iv) Existence of the equilibrium of type E requires (among other things) that

$$(k\alpha(2-\alpha) + (n-k)\alpha)u_F - c_p - kc_l \geq k(\alpha u_F - c_l) \Leftrightarrow (n\alpha - k\alpha^2)u_F \geq c_p.$$

Even if this condition is met, it is conceivable that

$$n\alpha(2-\alpha)u_F - c_p - nc_l \geq n(\alpha u_F - c_l) \Leftrightarrow n\alpha(1-\alpha)u_F \geq c_p$$

is violated and the equilibrium of type D does not exist. When $c_p, c_l \rightarrow 0$, the equilibrium of type D always exists. However, the condition

$$\alpha u_W - c_l \geq \left(\frac{k}{k+1} \alpha(1-\alpha) + \alpha \right) u_W - c_p - c_l$$

is clearly violated so that the equilibrium of type E does not exist. ■

Proof of Proposition 6. (i) From the existence conditions it is straightforward to see that both firms and workers receive higher expected payoff in an equilibrium of type other than A than in the equilibrium of type A whenever the corresponding equilibrium exists.

(ii) Since $c_l < c_p$, it immediately follows that workers receive a higher expected payoff in the equilibrium of type B than the equilibrium of type C. Therefore, C never payoff dominates B. Iff $c_p \leq nc_l$, the firm also receives a higher expected payoff in B than in C.

(iii) Assume that the equilibrium of type D exists. The existence conditions already state that the firm's expected payoff and all workers' expected payoffs must be higher in this equilibrium than in the equilibria of types A, B and C. Hence, if the equilibrium of type E does not exist, the first claim is proven.

Suppose now that the equilibrium of type E exists as well. The expected payoff for workers who choose $(p_{Wi}, l_{Wi}) = (1, 1)$ in the equilibrium of type E is the same as their payoff in the equilibrium of type D. Consider the inequality $\alpha(2 - \alpha)u_W - c_p - c_l \geq \alpha u_W - c_l \iff \alpha(1 - \alpha)u_W - c_p \geq 0$, which holds if the equilibria of type D and E exist. The inequality states that workers who choose $(p_{Wi}, l_{Wi}) = (0, 1)$ in the equilibrium of type E are worse off in this equilibrium than they are in the equilibrium of type D. Finally, $n\alpha(2 - \alpha)u_F - c_p - nc_l \geq (k\alpha(2 - \alpha) + (n - k)\alpha)u_F - c_p - kc_l$ can be restated as $(n - k)(\alpha(1 - \alpha)u_F - c_l) \geq 0$, which is obviously implied by $n\alpha(2 - \alpha)u_F - c_p - nc_l \geq \max\{n\alpha u_F - c_p, n(\alpha u_F - c_l), 0\} \Rightarrow n(\alpha(1 - \alpha)u_F - c_l) \geq 0$. Hence, the firm receives a higher expected payoff in the equilibrium of type D than in the equilibrium of type E.

(iv) Suppose that the equilibrium of type E exists. From the existence conditions, we can conclude that the k workers choosing $(p_{Wi}, l_{Wi}) = (1, 1)$ receive a higher expected payoff in E than they would in either B or C. Similarly, since $c_l < c_p$ the $n - k$ workers choosing $(p_{Wi}, l_{Wi}) = (0, 1)$ receive expected payoff that is not lower than their payoff in either B or C. It follows that neither B nor C can payoff dominate E. From the existence conditions it also follows that the firm's expected payoff is higher in E than in B, hence E payoff dominates B. Iff $(k\alpha(2 - \alpha) + (n - k)\alpha)u_F - c_p - kc_l \geq n(\alpha u_F - c_l)$ or $k\alpha(1 - \alpha)u_F + (n - k)c_l \geq c_p$, the firm's expected payoff in E also exceeds the expected payoff in C, in which case E also payoff dominates C. ■

Proof of Proposition 7. When each worker chooses $(p_{Wi}, l_{Wi}) = (0, 0)$, a best response for each firm is to choose $(p_{Fj}, l_{Fj}) = (0, 0)$. Similarly, when each firm chooses $(p_{Fj}, l_{Fj}) = (0, 0)$, a best response for each worker is to choose $(p_{Wi}, l_{Wi}) = (0, 0)$. Therefore, the described strategy profile constitutes a Nash equilibrium. Since firms do not hire any workers in this equilibrium, payoffs are $U_{Fj} = 0$ and $U_{Wi} = u_0$. ■

Proof of Proposition 8. Note that in equilibrium each worker is hired with probability $\alpha(2 - \alpha)$. For firm j the only profitable deviation could be to $(p_{Fj}, l_{Fj}) = (0, 0)$. The firm does not want to deviate in this way iff

$0.5\alpha(2-\alpha)nu_F - c_p \geq 0$. For worker i the only profitable deviation could be to $(p_{Wi}, l_{Wi}) = (0, 0)$. The worker does not want to deviate in this way iff $\alpha(2-\alpha)u_W - c_l \geq 0$. ■

Proof of Proposition 9. Note that in equilibrium each worker is hired with probability $\alpha(2-\alpha)$. Note further that firm j 's payoff function is again linear in l_{Fj} . Hence, if the firm were to deviate from $(p_{Fj}, l_{Fj}) = (0, n)$, it would deviate to $(p_{Fj}, l_{Fj}) = (0, 0)$. The firm does not want to deviate in this way iff $0.5\alpha(2-\alpha)nu_F - nc_l \geq 0 \Leftrightarrow 0.5\alpha(2-\alpha)u_F - c_l \geq 0$. For worker i the only profitable deviation could be to $(p_{Wi}, l_{Wi}) = (0, 0)$. The worker does not want to deviate in this way iff $\alpha(2-\alpha)u_W - c_p \geq 0$. ■

Proof of Proposition 10. Note that in equilibrium each worker is hired with probability $1 - (1-\alpha)^4$. Hence, firm j 's payoff is $0.5(1 - (1-\alpha)^4)nu_F - c_p - nc_l$. If the firm were to deviate to $(p_{Fj}, l_{Fj}) = (0, 0)$, the payoff would be zero. A deviation to $(p_{Fj}, l_{Fj}) = (0, 0)$ is thus not profitable iff $0.5(1 - (1-\alpha)^4)nu_F - c_p - nc_l \geq 0$. If firm j were to deviate to $(p_{Fj}, l_{Fj}) = (0, n)$, it would hire worker i with probability $\alpha(1-\alpha)^2 + 0.5\alpha(1 - (1-\alpha)^2) = 0.5\alpha(1 + (1-\alpha)^2)$. Thus, the firm does not want to deviate in this way iff $0.5(1 - (1-\alpha)^4)nu_F - c_p - nc_l \geq 0.5\alpha(1 + (1-\alpha)^2)nu_F - nc_l$. Again, firm j 's payoff function is linear in l_{Fj} . Therefore, the final deviation we must consider is to $(p_{Fj}, l_{Fj}) = (1, 0)$. If deviating in this way the firm would again hire worker i with probability $0.5\alpha(1 + (1-\alpha)^2)$. Thus, the deviation is not profitable if and only if $0.5(1 - (1-\alpha)^4)nu_F - c_p - nc_l \geq 0.5\alpha(1 + (1-\alpha)^2)nu_F - c_p$.

Consider now worker i who receives an equilibrium payoff of

$$u_0 + (1 - (1-\alpha)^4)u_W - c_p - c_l.$$

If deviating to $(p_{Wi}, l_{Wi}) = (1, 0)$ or $(p_{Wi}, l_{Wi}) = (0, 1)$, the worker would reduce the probability of being hired to $\alpha(2-\alpha)$. If deviating to $(p_{Wi}, l_{Wi}) = (0, 0)$, he would definitely not be hired. Comparing the resulting payoffs to the equilibrium payoff, we can immediately conclude that the worker does not want to deviate from $(p_{Wi}, l_{Wi}) = (1, 1)$ if and only if

$$(1 - (1-\alpha)^4)u_W - c_p - c_l \geq \max\{\alpha(2-\alpha)u_W - c_p, \alpha(2-\alpha)u_W - c_l, 0\}.$$

■

References

- Adams, R. (2011). *New York Times* prepares plan to charge for online reading, *The Wall Street Journal*, January 24. Retrieved January 26, 2011.
- Barron, J. M., M. C. Berger, and D. A. Black (1997). Employer search, training, and vacancy duration, *Economic Inquiry*, 35, 167–192.
- Blau, D. M., and P. K. Robins (1990). Job search outcomes for employed and unemployed, *Journal of Political Economy*, 98, 637–655.
- Brenčić, V. (2009). Employers' hiring practices, employment protection, and costly search: a vacancy-level analysis, *Labour Economics*, 16, 461-479.
- Brenčić, V. (2013). Evidence from online job boards and resume banks, Working paper, University of Alberta.
- Brenčić, V. and J. B. Norris. (2009). Employers' online search: an empirical analysis, *Industrial Relations*, 48, 684–709.
- Brenčić, V. and J. B. Norris. (2012). Employers' online recruitment and screening practices, *Economic Inquiry*.
- Castilla, E. J. (2005). Social networks and employee performance in a call center, *American Journal of Sociology*, 110, 1243–1283.
- DeVaro, J. (2005). Employer recruitment strategies and the labor market outcomes of new hires, *Economic Inquiry*, 43, 253-282.
- DeVaro, J. (2008). The labor market effects of employer recruitment choice, *European Economic Review*, 52, 283-314.
- Eisenmann, T., Parker, G., and M. Van Alstyne. (2011). Platform envelopment, *Strategic Management Journal*, 32.
- Farrell, J., and G. Saloner. (1985). Standardization, compatibility, and innovation, *RAND Journal of Economics*, 16, 70–83.
- Farrell, J., and G. Saloner. (1986). Installed base and compatibility: innovation, product preannouncements, and predation, *American Economic Review*, 76, 940–955.
- Gale, D. and L.S. Shapley. (1962). College admissions and the stability of marriage, *American Mathematical Monthly*, 69, 9-15.

- Gillard, D. (2009). Short and fraught: the history of primary education in England, www.educationengland.org.uk/articles/28primary.html.
- Gorter, C., P. Nijkamp, and P. Rietveld (1996). Employers' recruitment behavior and vacancy duration: an empirical analysis for the Dutch labour market, *Applied Economics*, 28, 1463–1474.
- Granovetter, M. (1995). *Getting a Job*. Harvard Press, Cambridge.
- Holzer, H. (1987). Hiring procedures in the firm: their economic determinants and outcomes. In *Human Resources and Firm Performance*, edited by R. Block et al. Madison, WI: Industrial Relations Research Association.
- Holzer, H. (1996). *What employers want: job prospects for less-educated workers*. New York: Russell Sage Foundation.
- Katz, L.F., and R.A. Margo. (2013) Technical change and the relative demand for skilled labor: The United States in historical perspective, conference paper.
- Katz, M., and C. Shapiro. Network externalities, competition, and compatibility, *American Economic Review*, 75, 424–440.
- Katz, M., and C. Shapiro. Technology adoption in the presence of network externalities, *Journal of Political Economy*, 94, 882–841.
- Kugler, A. D. (2003). Employee referrals and efficiency wages, *Labour Economics*, 10, 531–556.
- Kuhn, P., and H. Mansour. (2011). Is internet job search still ineffective? IZA Discussion Paper No. 5955.
- Kuhn, P. and M. Skuterud. (2000). Job search methods: internet versus traditional, *Monthly Labor Review*, October, 3–11.
- Kuhn, P. and M. Skuterud. (2004). Internet job search and unemployment durations, *American Economic Review*, 94, 218–232.
- Lebergott, S. (1957). Annual estimates of unemployment in the United States, 1900–1954, in *The Measurement and Behavior of Unemployment*, NBER, 211–242.

- Loury, L.D. (2006). Some contacts are more equal than others: informal networks, job tenure, and wages, *Journal of Labor Economics*, 24, 299–318.
- Malm, F. T. (1954). Recruiting patterns of labor markets, *Industrial and Labor Relations Review*, 507–525.
- Malm, F. T. (1955). Hiring practices and selection standards in the San Francisco Bay Area, *Industrial and Labor Relations Review*, 8, 231–252.
- Mencken, F. C., and I. Winfield (1998). In search of the right stuff: the advantages and disadvantages of informal and formal recruiting practices in external labor markets, *American Journal of Economics and Sociology*, 57, 135–153.
- Montgomery, J. (1991). Social networks and labor-market outcomes: toward an economic analysis, *American Economic Review*, 81, 1408–1418.
- Mortensen, D., and T. Vishwanath (1994). Information sources and equilibrium wage outcomes: it is who you know!, *Labour Economics*, 1, 187–201.
- Mortensen, D., and C. Pissarides (1999). Job reallocation, employment fluctuations and unemployment, in Woodford, M., and Taylor, J. (eds.), *Handbook of Macroeconomics*, vol. 1B, chapter 18, 1171–1128, Amsterdam: Elsevier Science/North-Holland.
- Palmer, A. E. (1905), with an introduction by Seth Low, *The New York public school: being a history of free education in the City of New York*, London: The Macmillan Company.
- Parker, G., and M. Van Alstyne (2005). Two-sided network effects: a theory of information product design, *Management Science*, 51.
- Petrongolo, B., and C. Pissarides (2001). Looking into the black box: a survey of the matching function, *Journal of Economic Literature*, 39, 390–431.
- Pinkston, J. (2012). How much do employers learn from referrals? *Industrial Relations*.
- Pissarides, C. (2000). *Equilibrium unemployment theory*, 2nd ed., Cambridge, Mass.: MIT Press.
- Poschke, M. (2011). The firm size distribution across countries and skill-biased change in entrepreneurial technology. *CIREQ Working Paper 8-2011*.

- Rees, A. (1966). Information networks in labor markets, *American Economic Review*, 56, 559–566.
- Rees, A., and G. Shultz (1970). *Workers and wages in an urban labor market*. University of Chicago Press, Chicago.
- Reynolds, L. (1951). *The structure of labor markets*, New York: Harper & Row.
- Rochet, J.-C., and J. Tirole. (2003). Platform competition in two-sided markets, *Journal of the European Economic Association*, 1, 990–1029.
- Rochet, J.-C., and J. Tirole. (2006). Two-sided markets: a progress report, *RAND Journal of Economics*, 37, 645–667.
- Roper, S. (1988). Recruitment methods and vacancy duration, *Scottish Journal of Political Economy*, 35, 51–64.
- Rysman, M. (2009). The economics of two-sided markets, *Journal of Economic Perspectives*, 23, 125–144.
- Simon, C. J., and J. T. Warner. (1992). Matchmaker, matchmaker: the Effect of old boy networks on job match quality, earnings and tenure, *Journal of Labor Economics*, 10, 306–329.
- Stigler, G. (1962). Information in the labor market, *Journal of Political Economy*, 70, 94–105.
- van Ours, J. C., and G. Ridder. (1992). Vacancy durations and the recruitment of new employees, *Journal of Labor Economics*, 10, 138–155.
- Weber, J. (2006). Strassburg, 1605: the origins of the newspaper in Europe, *German History*, 24, 387–412.
- West, E.G. (1978). Literacy and the Industrial Revolution, *The Economic History Review*, 31, 369–383.
- Weyl, E.G. (2010). A price theory of multi-sided platforms, *American Economic Review*, 100, 1642–1672.

Table 1: Employment-Related Advertising in Various Seventeenth and Eighteenth Century Newspapers

Year	Issues	# Ads from employers	# Ads from job seekers	% ads from employers	Newspapers	Location	Notes
1609	various	none	none	N/A	<i>Relation aller Firmenmen und gedencckwirdigen Historien</i>	Strasbourg, Holy Roman Empire	World's first newspaper, starting in 1605 and published in German.
1665-1666	various	none	none	N/A	<i>Oxford Gazette</i>	England	From issue 24 in 1666, renamed <i>London Gazette</i> (still in circulation)
1703	various	none	none	N/A	<i>Wiener Zeitung</i>	Austria	still in circulation
1708-1712	various	none	none	N/A	<i>Dublin Gazette</i>	Ireland	
1718	July 30	none	1	0	<i>Weekly Jamaica Courant</i>	Jamaica	Thomas Ward offers to teach reading, writing, and arithmetic on site, or to give private lessons in these topics to adults at their houses after hours.
1721	January 8-15, 22-29	none	none	N/A	<i>Boston Gazette</i>	Massachusetts Bay	
	various	none	none	N/A	<i>New-England Courant</i>	Massachusetts Bay	
1722	September 12	none	none	N/A	<i>Weekly Jamaica Courant</i>	Jamaica	
	May 14-21	none	none	N/A	<i>Boston Gazette</i>	Massachusetts Bay	
	various	none	none	N/A	<i>New-England Courant</i>	Massachusetts Bay	
1723	various	none	none	N/A	<i>New-England Courant</i>	Massachusetts Bay	

1724-1725	various	none	1	0	<i>Dublin Gazette</i>	Ireland	
1729	April 22-29, May 13-20, May 27-June 3, June 3-10, July 8-15	none	none	N/A	<i>Maryland Gazette</i>	Maryland	
1730-1731	various January issues	none	none	N/A	<i>Echo or Edinburgh Weekly Journal</i>	Scotland	
1731	November 6	none	none	N/A	<i>Barbados Gazette</i>	Barbados	
1737	Jan 27 – Feb 3	none	none	N/A	<i>Pennsylvania Gazette</i>	Pennsylvania	
1737	Sept 10-17	1	2	33.3	<i>South Carolina Gazette</i>	South Carolina	In one instance, same ad tries to buy and sell labor services; in an ad posted by a job seeker, a servant maid's time is offered for sale
	Aug 12-19	none	none	N/A	<i>Virginia Gazette</i>	Virginia	
1749	May 10	none	none	N/A	<i>Maryland Gazette</i>	Maryland	
1750	September 20	none	none	N/A	<i>Pennsylvania Gazette</i>	Pennsylvania	
1757	July 9	none	none	N/A	<i>Norwich Mercury</i>	England	
1767	March 16-23	none	2	0	<i>The Pennsylvania Chronicle and Universal Advertiser</i>	Pennsylvania	One of the posts is the advertised sale of a slave.
1769	January 19-21	2	4	33.3	<i>Dublin Mercury</i>	Ireland	
1773	December 9, 15, 22, 24	2	1	66.6	<i>Pennsylvania Journal and Weekly Advertiser</i>	Pennsylvania	
1775	May 9	1	1	50	<i>The South-Carolina Gazette and Country Journal</i>	South Carolina	Ad posted by "job seekers" is for "Two Negro Women" to be

Table 2: Employment-Related Advertising: A Tour Through *The (London) Times*

		#Ads from employers	# Ads from job seekers	% ads from employers	Notes
1785	Mon, Oct 24	none	none	N/A	Founded on January 1, 1785 as <i>The Daily Universal Register</i>
1795	Sat, Oct 24	none	none	N/A	Changed name to <i>The Times</i> on January 1, 1788
1805	Thurs, Oct 24	2	1	66.7	Front page had 3 ads. Very first entry of the newspaper. in column 1 of page 1, sought contractors for rebuilding the royal circus.
1815	Tues, Oct 24	1	22	4.3	Ads appear on the front and last pages of the newspaper, sprinkled throughout many other ads that have nothing to do with employment.
1825	Mon, Oct 24	13	47	21.7	38 ads posted by either side are sprinkled throughout the first page, and another 22 ads are posted by job seekers in a "Want Places" section later in the newspaper
1835	Sat, Oct 24	4	29	12.2	
1845	Fri, Oct 24	81	108	42.9	
1855	Wed, Oct 24	149	704	17.5	Many ads from both sides randomly mixed together with other ads unrelated to employment; then a section of "Want Places" with a few hundred more ads placed by job seekers
1865	Tues, Oct 24	145	436	25.0	Many ads from both sides randomly mixed together with other ads unrelated to employment; then a section of "Want Places" with a few hundred more ads placed by job seekers
1875	Sat, Oct 23	90	248	26.6	Ads from both sides mixed together with ads unrelated to employment; then a section of "Want Places" with ads placed by job seekers
1885	Sat, Oct 24	39	126	23.6	Ads from both sides mixed together with ads unrelated to employment; then a section of "Want Places" with ads placed by job seekers
1895	Thurs, Oct 24	26	64	28.9	26 ads under "Situations, &c., VACANT" followed by 23 under "Situations, &c., WANTED" followed by 41 under "WANT PLACES"
1905	Tues, Oct 24	24	81	22.9	50 "WANT PLACES" ads followed by 31 "Situations, &c., WANTED" ads followed by 24 "Situations, &c., VACANT" ads
1915	Mon, Oct 25	69	56	55.2	
1925	Sat, Oct 24	129	128	50.2	
1935	Thurs, Oct 24	132	138	48.9	
1945	Wed, Oct 24	44	15	74.6	Late London edition

1955	Mon, Oct 24	130	78	62.5	Royal edition
1965	Mon, Oct 24	113	41	73.4	Late London edition
1975	Fri, Oct 24	126	11	92.0	
1985	Thurs, Oct 24	57	4	93.4	
1991	Thurs, Oct 24	numerous	none	100.0	15 full pages of ads, including a 12-page "Appointments" section

Table 3: Employment-Related Advertising: A Tour Through *The (New York) Times*

		# Ads from employers	# Ads from job seekers	% ads from employers	Notes
1851	Fri, Oct 24	None	None	N/A	<i>Times</i> founded on September 18, 1851
1861	Thurs, Oct 24	8	141	5.4	“Situations Wanted” ads posted by job seekers in 2 sections (females, males)
1871	Tues, Oct 24	8	130	5.8	
1881	Mon, Oct 24	6	156	3.7	
1891	Sat, Oct 24	6	66	13.2	
1901	Thurs, Oct 24	14	78	15.2	“Situations Wanted” (by gender) listed under occupational subheadings
1911	Tues, Oct 24	22	74	22.9	Posting prices listed for both sides
1921	Friday, Oct 24				
1931	Sat, Oct 24	61	96	38.9	Posting prices listed for both sides
1941	Fri, Oct 24	219	94	70.0	
1951	Wed, Oct 24	numerous	numerous	95.0	About 63 columns of ads (each containing many ads) spanning 7 pages. % ads from employers is approximate
1961	Tues, Oct 24	numerous	numerous	88.0	% is approximate
1971	Sun, Oct 24	numerous	numerous	96.0	Ads span all of Section 9 (p. 1-34) and some ads in other sections. % is approximate
1981	Sat, Oct 24	289	28	91.2	Help Wanted ads no longer appear in separate gender categories
1991	Thurs, Oct 24	686	11	98.4	All ads on p. B21-B23. Recession of 1990-1991 had ended in March, but national unemployment remained at 7 percent in October during the so called “jobless recovery”
2001	Wed, Oct 24	381	2	99.5	
2011	Mon, Oct 24	224	4	98.2	This was a recession month.

Figure 1: *The London Times* 1815-1991

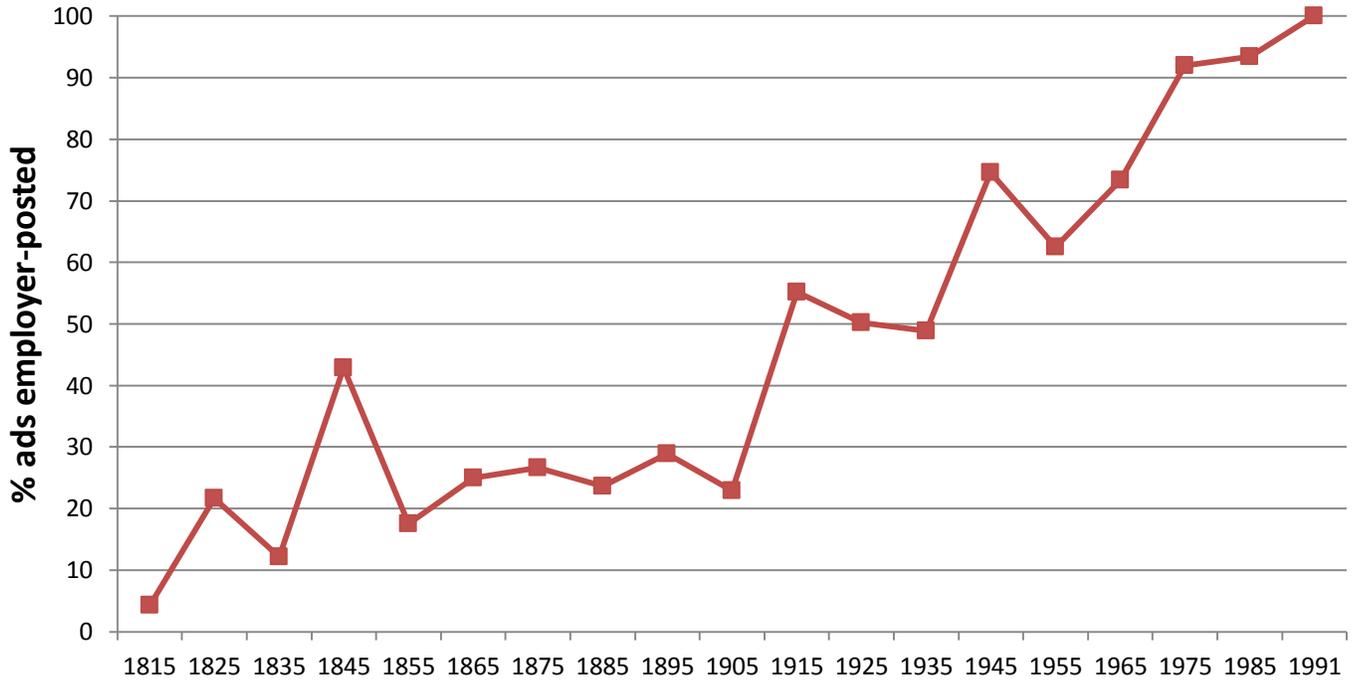
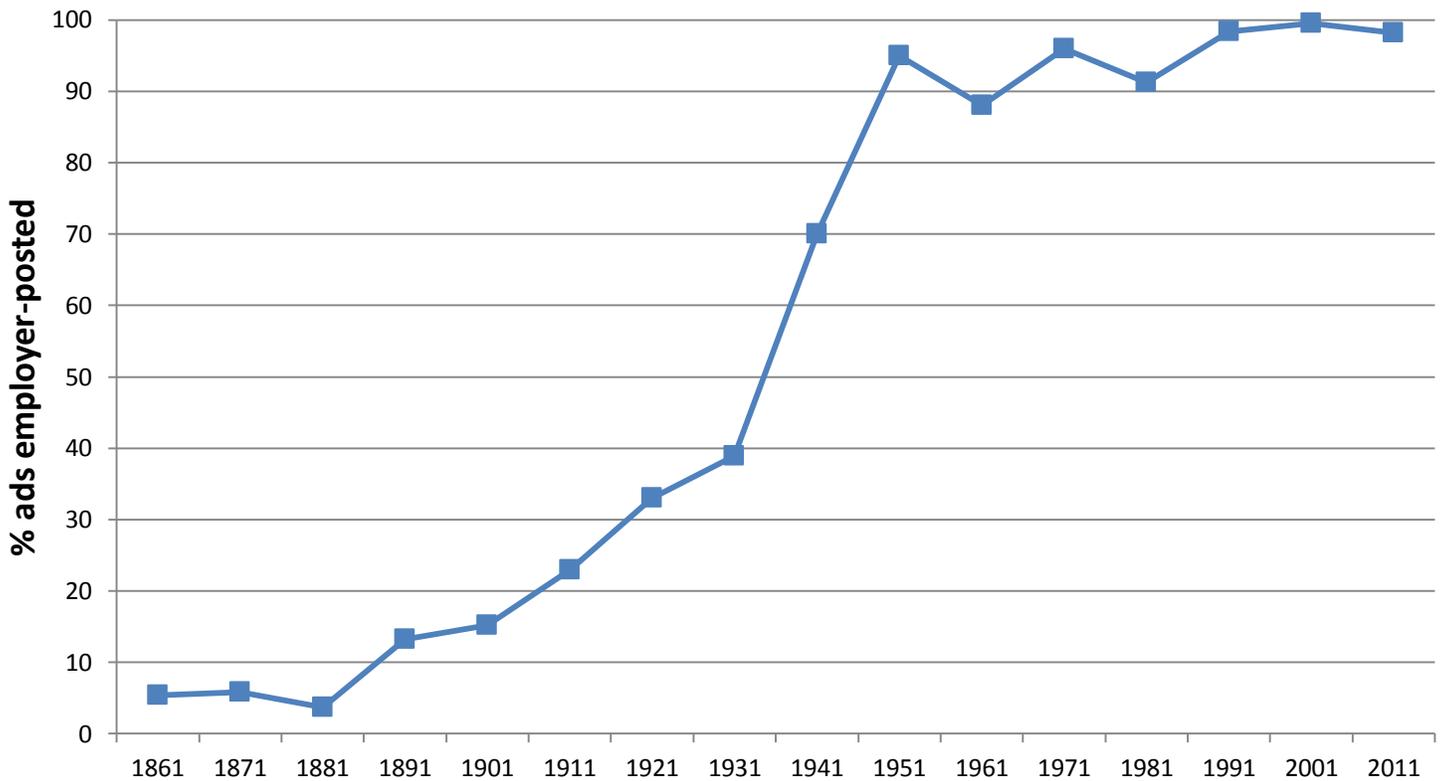
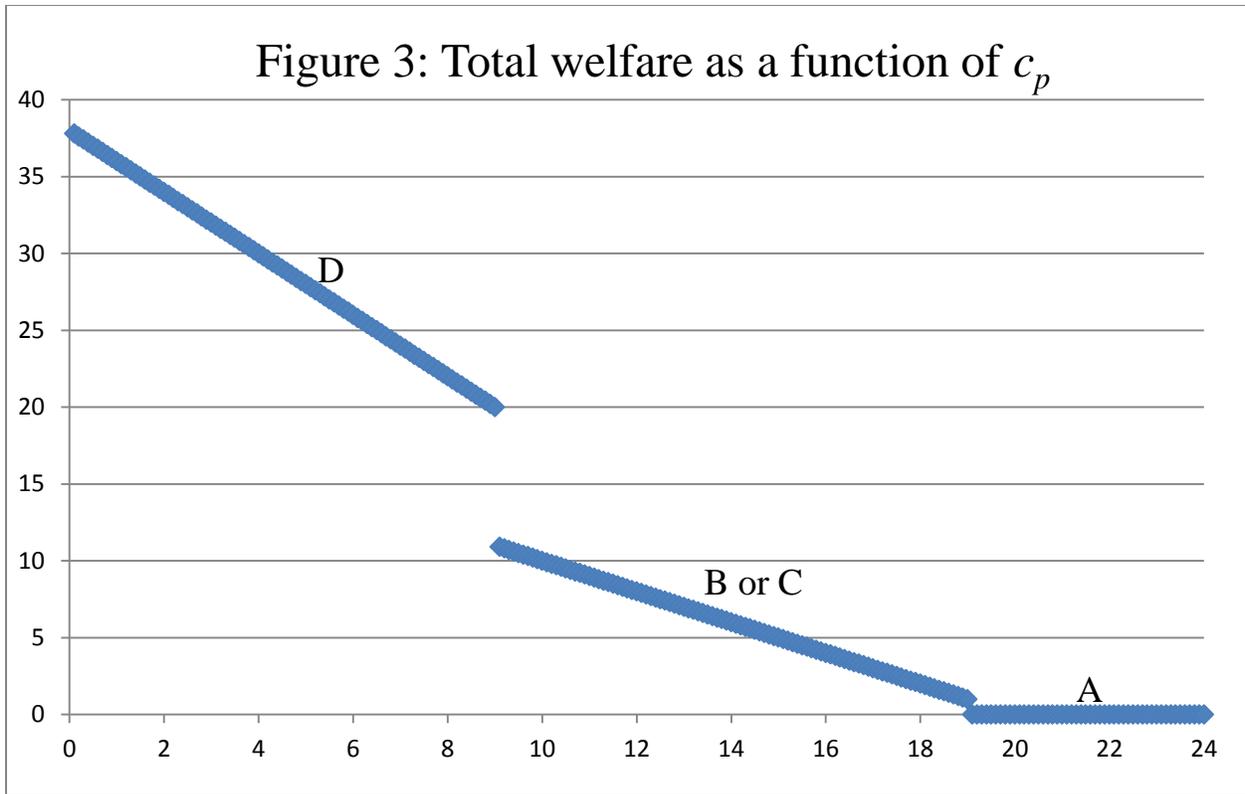
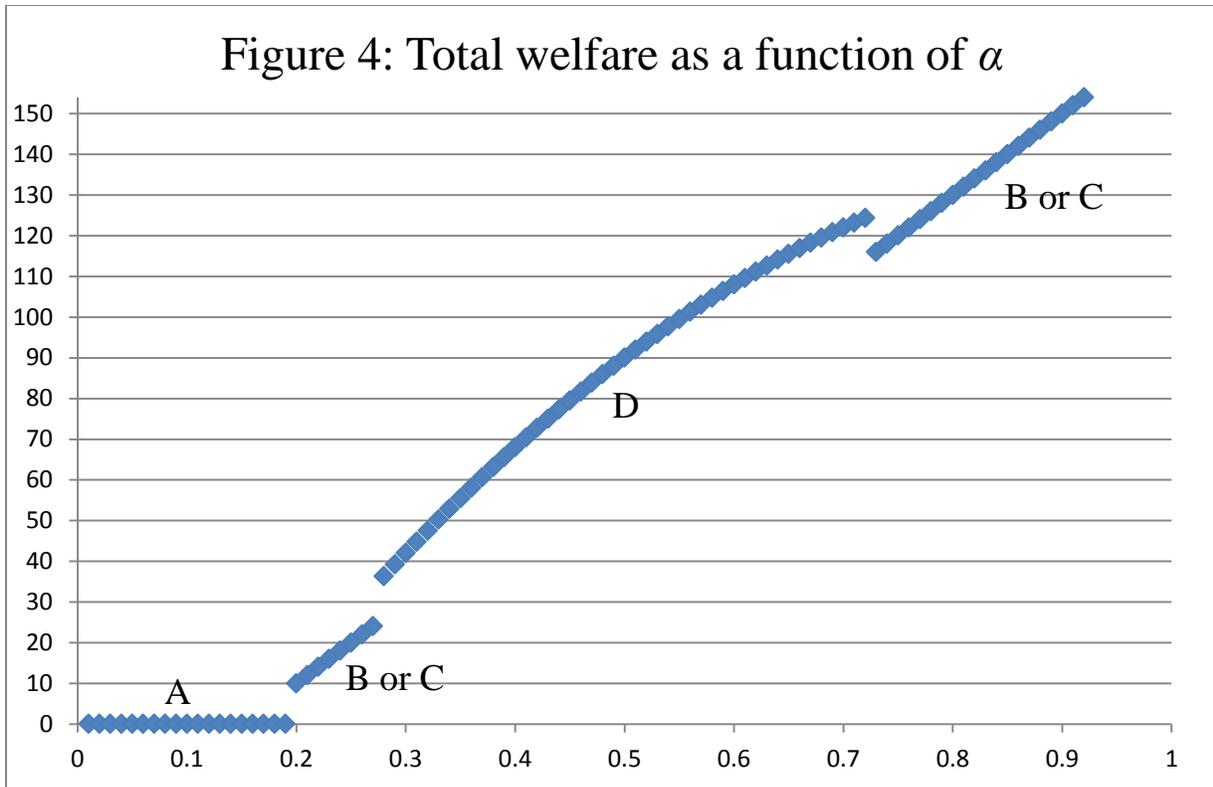


Figure 2: *The New York Times* 1861-2011





Note: Graph shows welfare as a function of c_p , for $n = 1$, $u_W = u_F = 100$, $c_l = u_0 = 0$, $\alpha = 0.1$.



Note: Graph shows welfare as a function of α , for $n = 1$, $u_W = u_F = 100$, $c_p = 20$, $c_l = 10$, $u_0 = 0$.