

NBER WORKING PAPER SERIES

WIRING THE LABOR MARKET

David H. Autor

Working Paper 7959  
<http://www.nber.org/papers/w7959>

NATIONAL BUREAU OF ECONOMIC RESEARCH  
1050 Massachusetts Avenue  
Cambridge, MA 02138  
October 2000

This is a draft article for a forthcoming *Journal of Economic Perspectives* symposium on Electronic Commerce and the Economy. I thank Daron Acemoglu, Joshua Angrist, Hoyt Bleakley, Brad DeLong, Lawrence Katz, Alan Krueger, Kevin Lang, Frank Levy, Richard Murnane, Tim Taylor, and Michael Waldman for excellent insights and editorial suggestions. I am grateful to Simone Berkowitz for research assistance. The views expressed in this paper are those of the author and not necessarily those of the National Bureau of Economic Research.

© 2000 by David H. Autor. All rights reserved. Short sections of text, not to exceed two paragraphs, may be quoted without explicit permission provided that full credit, including © notice, is given to the source.

Wiring the Labor Market  
David H. Autor  
NBER Working Paper No. 7959  
October 2000  
JEL No. J0, O3

**ABSTRACT**

Workers and jobs are naturally heterogeneous and the quality of their interaction when paired is difficult to forecast. The Internet promises to open new channels for worker-firm communications. What are the consequences of this opening? I discuss three labor market features that may be altered: how worker-firm matches are made; how labor services are delivered; and how local markets shape labor demand. Theory predicts these developments will produce social benefits. But the gains are unlikely to be uniform and realizing them will generate novel problems. One result may be the formation of new institutions to address issues accompanying these opportunities.

David Autor  
Department of Economics  
MIT, E52-371  
50 Memorial Drive  
Cambridge, MA 02142  
and NBER  
dautor@mit.edu

The labor market is replete with imperfect and asymmetric information. Workers and jobs are naturally heterogeneous, and the quality of their interaction when paired is notoriously difficult to forecast. Workers searching for a job are unlikely to be fully informed about job characteristics, and firms cannot exhaustively screen and negotiate with all applicants. Electronic commerce specifically, and the Internet more generally, promise to open new channels for improved worker-firm communications. What are the consequences of this opening?

In this essay, I discuss three labor market features that are likely to be affected. First, the Internet will change the way that employer-employee matches are made. Second, labor services – the actual work done by employees – may increasingly be delivered over the Internet rather than on-site. Third, the demand for labor may become less dependent on local market conditions. Economic theory offers several insights into why these developments will produce social benefits. But these gains are unlikely to be uniformly enjoyed and the process of realizing them will generate novel problems. One of the most significant impacts of the Internet on labor markets may be the creation of new institutions to address issues accompanying these opportunities.

### **Three Consequences of the Internet for Labor Markets**

#### *How Workers and Firms Search for One Another*

Workers use numerous avenues to locate jobs, including personal referrals, direct employer contacts, union and professional registers, private employment agencies, and newspaper advertisements. Added to this list recently are: internet job boards, websites offering searchable databases of job listings and resumes; corporate websites permitting online job applications; and employer-initiated employee searches that target promising ('passive') candidates via their online credentials.

Little is known about the importance of online job applications or direct employer-initiated contacts with potential candidates. However, online job posting has grown spectacularly. Estimates place the number of online job boards at over 3,000, the number of (unique) active resumes online at over 7 million, and the number of job postings (not necessarily unique) at 29 million (Boyle et al., 1999; Computer Economics, 2000). The leading job board, Monster.Com, offered 3.9 million resumes and 430,000 jobs in August 2000. Several prominent job boards are provided on a nonprofit basis. For example, the U.S. Department of Labor runs America's Job Bank ([www.ajb.org](http://www.ajb.org)) which makes the job listing and search services of the U.S. Public Employment Service broadly accessible, and Canada's CareerOwl ([www.careerowl.ca](http://www.careerowl.ca)) job search facility, developed by university faculty volunteers, provides job search assistance for Canadian students (Nakamura and Pugh, 2000).

Job boards hold several advantages over their textual counterpart, newspaper help-wanted ads. They offer more information about more jobs in more locations than is conceivable for paper equivalents. They are easier to search. They are potentially more up to date because ads are posted immediately and can be edited frequently. They allow individuals to advertise their skills to employers as well as the reverse. Employers can also use job boards for candidate screening by specifying that their job listings and online applications are only made available to candidates possessing specific credentials such as education or experience.

Job boards can also take an active role in matching: rather than waiting on workers or firms to find one another, software can parse posted job listings and resumes to identify plausible matches and notify both parties. Some matching algorithms also learn from workers' behavior, noting which jobs workers apply to and adapting their recommendations accordingly. In addition, whether over a job board or another on-line connection, employers can use the Internet

to administer skills or personality tests at the point of application.

Job boards reach more attentive eyes at a lower cost than newspaper advertisements. A job advertisement in the Sunday *New York Times*, circulation 1.7 million, costs \$4,500 (Audit Bureau of Circulations). By contrast, Monster.com, which had 3.8 million unique visitors in May 2000 (MediaMetrix), charges \$137 for a 30 day advertisement – less than 5 percent of the *Times*.

Internet job search is already commonplace. About 15 percent of unemployed job seekers regularly used the Internet as a means of job search in 1998, quite comparable to the fraction that placed or answered traditional help-wanted ads, according to data from the Current Population Survey (Kuhn and Skuterud, 2000). In the medium term, job boards are likely to displace newspaper advertisements as the leading conduit for job listings. For example, companies surveyed by Li et al. (2000) project a 31 percent decline in print recruitment advertising by 2004 as compared to a 52 percent increase in online advertising.

Job boards and other Internet labor market connections should increase the efficiency with which workers are matched to jobs. In part, greater efficiency arises simply because more initial meetings between potential employees and workers are possible. In part, greater efficiency might also arise from online candidate screening. For example, 7-Eleven convenience stores offer job applicants an electronic interview questionnaire that they complete over the telephone. By fine-tuning its interview questions, 7-Eleven improved its screening process and its retention rates rose (*Economist*, 2000b).

The improvement in matching efficiency may already be evident. Despite the fact that newspaper help wanted ads usually increase when the unemployment rate falls, the Conference Board's Help Wanted advertising index has been flat throughout the 1990s economic boom (Krueger, 2000). One reading of these facts is that the Beveridge curve – the negatively sloped

relationship between job vacancies and unemployment – has shifted towards the origin, which is consistent with an improvement in the aggregate job matching efficiency of the U.S. labor market (Bleakley and Fuhrer, 1997). Since vacancies are normally measured by the Conference Board's index of newspaper help wanted listings, a plausible alternative explanation noted by Katz and Krueger (1999) is that vacancy listings have merely migrated from newspapers to the Internet. The improvement in labor market matching efficiency is unlikely to be entirely illusory, however; recent estimates find that the unemployment rate consistent with non-accelerating wage inflation also fell during the 1990s (Gordon, 1998; Katz and Krueger, 1999).<sup>1</sup>

Labor market search theory predicts that lower cost job search will raise productivity (Mortensen, 2000; Pissarides, 1990). Because workers and firms can consider more potential matches more rapidly, their reservation match quality – the minimum productivity an employer will tolerate, the minimum wage a worker will accept – both rise. Higher match quality raises output, and worker earnings and firm profits rise accordingly. In general, lower search costs will also reduce unemployment.<sup>2</sup> In addition, better job matches should reduce workers' incentive to separate from their employers. Conversely, since the Internet may make it substantially easier for workers to seek better job offers while employed – and for employers to seek their replacements when they depart – this may induce more job separations.

Kuhn and Skuterud (2000) report that 7 percent of employed workers regularly used the web to search for a new job in 1998, a volume of on-the-job search that is an order of magnitude

---

<sup>1</sup> The rapid growth of U.S. temporary help firms that match workers to jobs has probably also reduced help wanted advertising and increased matching efficiency (Autor, 2000b), an idea explored empirically by Katz and Krueger (1999).

<sup>2</sup> Under certain conditions, the increase in reservation match quality can fully offset the unemployment reductions that would otherwise accrue (Burdett, 1981).

larger than the amount that was thought to take place with conventional methods. This suggests that the Internet may have a sizable impact on job search for incumbent workers. In fact, median tenure of employed workers has fallen notably for both genders and all age groups since 1991 (U.S. Bureau of Labor Statistics, 2000b), a trend consistent with higher turnover.

While it is difficult in the present economy to disentangle the impact of decreased search costs from the temptations of bountiful job opportunities and a business culture that has become more willing to carry out layoffs, the subject deserves careful study. While issues of self-selection will complicate inquiry, it will be important to explore whether employers who search for workers on job boards versus help wanted ads find workers faster, and find better workers – and similarly for workers who job search online. Notably, the Internet also provides an opportunity to collect more and possibly better labor market data. While research data sources typically provide a point-in-time snapshot of the labor market, the ‘transaction history’ generated by web-based job boards, job applications, and other online artifacts may provide a new tool for studying labor market dynamics.

#### *How Labor Services are Delivered*

The Internet is likely to change how many workers deliver labor services. For example, falling telecommunications costs means that call center employees can handle telecommunications traffic regardless of where it originates (*Economist*, 1997; Uchitelle, 2000). Improvements in communications and control technology likely mean that people who monitor equipment or other workers can perform their tasks at greater physical remove. Remote access to e-mail and company documents will enable many workers to perform some or all of their work from home or elsewhere. Close to 10 percent of the labor force was engaged in some form of telecommuting as of 1997, and that penetration was growing at 15 percent annually (National

Science Foundation, 1998, Ch. 8).<sup>3</sup>

One potential source of efficiency gains from delivering services remotely is that hours spent in unproductive commuting may be replaced by rapid online delivery. However, evidence suggests that telecommunications and face-to-face interactions are complements rather than substitutes (Gaspar and Glaeser, 1998), in which case telecommuting and physical commuting may rise in tandem. Survey data find that workers who use the Internet extensively at home have increased working hours at home without decreasing the amount of time working in the office (Nie and Erbring, 2000). One reason may be that by increasing the productivity of working at home, telecommuting may induce substitution from leisure to production.

A related observation is that along with changing how workers supply skills, the Internet may change how they acquire them. A vast economic literature beginning with Becker (1964) emphasizes the importance of skills training to worker earnings and mobility, and recent evidence confirms that the majority of employers spend substantially on both informal and formal workplace skills training (Frazis et al. 1998). Skills training delivered over the Internet has the potential to substantially reduce the cost and increase the convenience of ongoing skills development. While at this point the efficacy of online training is unproven, it will be critical to study who benefits, in what subject areas, and at what cost.

#### *How Local Markets Shape Labor Demand*

When the work product is primarily information, improvements in information and communications technology enable firms to transmit the work to the workers. For example, check processing at U.S. bank branches – a low-skilled, labor-intensive task – had historically

---

<sup>3</sup> Little is known about who telecommutes and what services they provide remotely. Most data come from industry-sponsored studies, which is undesirable.



been carried out in near physical proximity to bank branches due to federal regulations requiring rapid turnaround of physical paper checks (within 48 hours for in-state checks). With the advent of digital imaging, banks discovered that they could electronically ship images of paper checks to out-of-state facilities, thus disaggregating the information and paper processing tasks into separate jobs performed in different locations and coordinated by networked computers (Autor, Levy and Murnane, 2000b).

As this example suggests, businesses are likely to leverage the Internet to subdivide work into component parts, electronically ship subtasks to sources of labor supply, and use information technology to coordinate the geographically dispersed production process (Brynjolfsson and Hitt, forthcoming). These forces will augment the trend towards greater outsourcing of business services (Abraham and Taylor, 1996). Firms may find it less necessary to hire workers whom they only use infrequently, reducing transaction costs. This will in turn increase the extent of the market for specialized skills, yielding accompanying gains from specialization of labor.

Which tasks – and associated workers – are likely to be outsourced in response to these technological opportunities is a worthwhile question for research. On the one hand, the work products of professional and technical workers most lend themselves to electronic delivery. On the other hand, the routine information processing tasks performed by many clerical and service workers, such as the banking employees discussed above, may require little in person contact and hence can be easily coordinated and monitored over electronic networks (Autor, Levy and Murnane, 2000a).

The impacts of e-commerce on labor outsourcing and specialization have counterparts in the product market. By allowing consumers to shop for products and services from distant suppliers,

e-commerce effectively separates the storefront from its physical operations. Consequently, suppliers of goods have less incentive to locate near demanders of goods (Kolko, 1999). Freed from some of the constraints of proximity, labor (and product) demand and supply implicitly operate in larger markets.

Trade theory suggests that integrating labor markets that were geographically (semi-) independent has substantial benefits. By redistributing work to places where labor is comparatively cheap, firms reduce costs and regions exercise comparative advantage. Producers realize scale economies that were infeasible in small markets, thereby raising productivity and wages, and consumers gain specialized services that were previously only available in large markets.

The combination of increasingly mobile labor demand and increasingly flexible labor supply mean that the labor supply and demand facing any given geographic region become effectively more elastic. Because firms can more readily arbitrage regional wage and price differentials (both intra- and internationally), workers with similar skills in different locations should receive (more) similar wages. While this is bad news for those who have been hiring labor in slack labor markets, it can also mitigate regional pockets of unemployment and even reduce aggregate inflationary pressure. The impacts may be particularly significant for less educated workers who are substantially less likely to relocate in response to regional booms and busts than are their college educated counterparts (Bound and Holzer, 2000). At present, much anecdotal evidence suggests that firms are leveraging the decline in communications costs offered by the Internet to arbitrage regional labor market differentials (Uchitelle, 2000; Verhovek, 2000). It will be important to study this phenomenon closely using representative data.

## Some Mitigating Concerns

E-commerce and the Internet are likely to offer net social gains by improving labor market efficiency. But these gains will not be uniformly enjoyed and the process of realizing them may generate novel problems. Here I provide a few examples that I see as particularly relevant.

### *Adverse selection of job applicants*

Abusing terminology slightly, information about workers' attributes can be usefully grouped into low and high "bandwidth" varieties. Low bandwidth data are objectively verifiable information such as education, credentials, experience, and salaries. High bandwidth data are attributes such as quality, motivation, and "fit" that are typically hard to verify except through direct interactions such as interviews and repeated contact. The Internet makes low bandwidth data cheap, dramatically reducing the cost of learning about and applying for jobs. For example, browsing job boards is almost always free and the opportunity to transmit job applications to multiple employers is commonplace.

A natural consequence of lowering the cost of application is that many workers will apply for many more jobs. In fact, *excess application* appears to be the norm for online job postings, with employers reporting that they frequently receive unmanageable numbers of resumes from both under- and over-qualified candidates, often repeatedly, and frequently from remote parts of the world (Li et al., 2000; Moe and Blodgett, 2000).

As discussed by Lang (2000), this is potentially problematic. Consider a situation where potential employees can judge whether they are a good fit for a job (i.e., they know their high-bandwidth data) but employers would have to go through a process of interviewing and screening to collect this information. In a world where applying for jobs is costly, individuals who know that they are poor candidates for a position will not bother to apply. Lowering

application costs to near zero does not reduce the problem of gathering high bandwidth information. Rather, it shifts the cost either onto the employer, or onto workers who must implicitly pay more to establish their qualifications. When direct application costs fall, firms may introduce additional hurdles to reduce adverse selection and improve the overall quality of their application pool.<sup>4</sup>

Do we see any evidence of this? Partly in response to the problem of excess and inappropriate applications, many job boards offer pre-filtering to prevent unqualified applicants from submitting resumes. Web-based services like Pre-employ.com, Avert.com, and PreScreenAmerica.com offer online background checks and pre-screening services. The advertisement for one online screening service asks: “Did he really go to Harvard? Is she really Microsoft-certified? We'll help you be sure.” The widely advertised Futurestep.com website (the web entry of a leading executive recruiting firm) warns applicants of a 30-60 minute online application process that is required to become eligible for career services. Presumably, this time commitment wards off (some) non-serious applicants.

There is substantial evidence that a large fraction of all jobs are found through personal referrals rather than formal contacts, and adverse selection of job applicants may be an important reason why (Greenwald, 1986 and Montgomery, 1991). For example, Li et al. (2000) reports that of approximately three thousand Internet users surveyed in 1999, 4 percent had found their most recent job over the Internet relative to 6 percent via temporary help agencies, 23 percent via the

---

<sup>4</sup> A standard result of signaling models is that high quality workers pay to acquire a signal that distinguishes them from others. If the price of the signal falls, lower quality workers also acquire it and employers face more difficulty separating wheat from chaff. Gibbons and Waldman (1999) provide an excellent overview of the large literature on asymmetric information in labor markets that begins with Spence (1973).

newspaper and 40 percent via referral. If online job application exacerbates adverse selection, one perverse consequence may be that personal referrals become more important in a wired labor market.

In fact, many employers appear to believe that resumes posted to job boards represent an adversely selected pool (Li, 2000; iLogos, 1999). A 1998 survey of job seekers found that 71 percent of posted resumes belonged to unemployed workers (Source InterBiznet.com, as reported by Boyle et al., 1999). One recruiting executive is quoted in Boyle et al. (p. 45) as saying that job boards are populated with resumes from four adversely selected pools: “The unhappy (and thus probably not a desirable employee); the curious (and therefore likely to be a ‘job-hopper’); the unpromotable (probably for a reason); and the unemployed (probably for a worse reason).”

Perhaps due to this perception, employers increasingly use the Internet to bypass the pool of self-identified job seekers and target “passive candidates,” currently employed individuals who might be enticed by a better opportunity. The term of art for this practice is “talent mining,” trolling company web sites, chat rooms, and other online media to identify and solicit applications from desirable candidates. While recruiting agencies that specialize in hiring the already-employed have existed for some time, they have primarily served executive labor markets. The price reductions in identifying and targeting passive candidates offered by the Internet may make this form of employer pursuit more commonplace in less rarified labor markets, with potentially adverse consequences for active job seekers.

The ‘market’ for undergraduate college admissions, which is several years ahead of the labor market in adopting online applications, provides an instructive example. Electronic applications are credited in part with an estimated 30 percent rise in the number of college applications

between 1998 and 2000, five times the growth rate of the college applicant pool (*Baltimore Sun*, 1999; Myers, 2000). Because online applications are easy to file in bulk, their signaling content is accordingly devalued, creating substantial uncertainty for colleges about which students are genuinely motivated to attend (Roane, 2000). One possible consequence is that the fraction of admissions made on an ‘early decision’ basis – where an application signifies a binding unilateral commitment to attend – has doubled in the past five years to 25 to 40 percent (Brophy, 2000). While binding pre-commitment may solve the signaling problem, the new equilibrium is unlikely to be welfare improving. College applicants increasingly face the dilemma of restricting their choice set to a single school or facing lower acceptance odds in the residual non-early applicant pool.<sup>5</sup>

No data are yet available on how the Internet is shifting the pool of workers from which employers hire. However, these observations suggest that the impacts need not be neutral across skill and employment groups. Understanding who is affected and how are worthwhile topics for exploration.

#### *Who is Matched to Whom*

Reductions in search costs for employees and employers should yield aggregate gains in productivity and wages as the quality of job matches improves. However, aggregate gains do not imply Pareto improvements: productivity gains for some workers may be partially offset by losses for other workers.

A simple example illustrates the pitfalls. Consider a world where firms can choose between

---

<sup>5</sup> Other factors contributing to the rise in early decision college admissions may include greater use of early decision as a price discrimination mechanism, and efforts by colleges to improve their standings in national rankings by raising their ‘yield’ (the fraction of students admitted who ultimately attend). I thank

three production technologies, a general use technology that requires both high and low skill workers and two skill-specific technologies, one requiring exclusively high and the other requiring exclusively low skill workers. Each technology has the same cost but the high-skill technology is extremely productive when paired with high ability workers and is unproductive with low ability workers.

Assume that firms must make their capital investments before hiring (i.e., when building plants) and hence they choose the production technology that suits the expected characteristics of their recruits. In the pre-Internet world, there are few applicants per job and hence firms hire the first worker that applies. In the post-Internet world, each job receives numerous applications. Consequently the Internet allows firms to choose workers that suit their production technology, moving the labor market from a pooling equilibrium, in which high and low skill workers work together, to a separating equilibrium in which they do not. How does the improvement in job matching impact worker well being?

The answer will depend on whether the skill-specific production technologies are characterized by what I'll call weak or strong skill match. Strong skill match is a case where each worker type is absolutely more productive with the skill-specific technology than with the general use technology (for example, because the skill specific technologies require either brains or brawn whereas the general use technology requires some of both). Weak skill match is a case where one skill group – high skill, in this example – is more productive with the skill-specific technology while the other group is more productive with the general use technology (for example, because high-skill capital substitutes for brawn but low-skill capital cannot substitute for brains). In this case, improvements in job matching benefit high skill workers and harm low

skill workers who previously gained from being pooled with high skill.<sup>6</sup>

Figure 1 provides a numerical example. Panel A depicts strong skill match. High skill workers produce 5 with the general use technology and low skill workers produce 4. Total output is 9. The invention of the Internet yields a Pareto improvement. Since firms can now freely select for worker ability, they invest in skill-specific technologies. As each worker is paired with the appropriate technology, output rises to 14 overall, increasing to 8 for high skill workers and 6 for low skill workers.

Contrast this to the weak skill match case depicted in Panel B where high skill workers are more productive with the high-skill technology but low-skill workers are less productive with the low-skill technology. Here, the Internet is less benign. Workers again separate by ability as firms invest in skill-specific technologies. Total output increases, in this case to 11, and wages for high ability workers rise to 8. But as low ability workers are separated from high ability workers, their wages fall from 4 to 3.

While this example is quite stylized, it captures the flavor of more sophisticated models in which improvements in worker-firm matching generate increased workplace segregation by skill, yielding absolute declines in the well being of less-skilled workers (Acemoglu, 1999; Kremer and Maskin, 1996).

### *Geography and Inequality*

If electronic delivery of labor services effectively integrates economically distinct markets, geographic variation in skill prices should converge. But factor price equalization is highly redistributive, placing downward pressure on the wages of workers whose skills become

---

<sup>6</sup> A third possibility is ‘linear skill match’ where gains to one group are exactly offset by losses to another, yielding redistribution without corresponding productivity gains.



relatively more abundant when markets integrate. For example, given that the United States has relatively high skill levels by world standards, further integration of the U.S. economy with world labor markets almost certainly increases the relative abundance of less skilled labor, placing downward pressure on the wages of the less skilled U.S. workers.

Further, economic integration may also exacerbate wage inequality within skill groups (Acemoglu, Angrist and Autor, 2000). Consider a case of two cities of identical size, originally operating as separate markets. The workers in City 2 have more talent than the workers in City 1; however, the local demand for talent in City 1 is higher than in City 2, and so workers in City 1 initially earn approximately the same as those in City 2 despite their lesser talent. Integration of these markets creates a single market price for talent, but in this case earnings *diverge*. When markets were isolated, heterogeneity in demand masked heterogeneity in underlying talent endowments. When a single price for talent prevails, electronic markets more accurately target riches to those with the most generous endowment. Thus, whether integration of markets is a force for equality or inequality depends in part on the dispersion of the underlying talent distribution relative to the levels of local demand.<sup>7</sup>

The Internet also could heighten inequality by concentrating the distribution of market rewards among fewer participants. As Sherwin Rosen's prescient 1981 paper "The Economics of Superstars," observed, advances in communications technology – of which the Internet is an important example – can create winner-take-all markets. The primary insight is that by allowing individuals with extraordinary talent to serve substantial markets almost single-handedly, communications technologies may displace lesser talents, redistributing a larger share of the

---

<sup>7</sup> Brynjolfsson and Smith (1999) present evidence that Internet-based business-to-consumer commerce leads to increased price dispersion in commodity product markets.

rewards to a smaller number of superstars. More recently, Rosen (2000) makes a similar observation specifically about the Internet, writing: “When and if teachers use the Internet and other media to personally teach millions of students at one time, star teachers will earn at least as much as star athletes.” Frank and Cook (1995) make a controversial argument that the winner-take-all society is already a reality.

Ironically, the Internet also exerts a countervailing force against the superstar phenomenon. Internet-based services such as Napster.com, MP3.com, or Gnutella (gnutella.wego.com) lower to near zero the cost of transmitting and reproducing (‘pirating’) intellectual property such as software, music, video, and text. By making intellectual property rights harder to enforce, the Internet could increase the market scope of ‘superstars’ without necessarily raising their incomes.<sup>8</sup>

These observations reinforce the view that cheaper job search, integration of labor markets, and online delivery of labor services, while beneficial in the aggregate, are not necessarily beneficial to all groups.

### **Institutional Responses: Intermediation Versus Free Agency**

A decline in communications and coordination costs coupled with the growing feasibility of supplying labor services from remote locations offers an opportunity to unbundle labor service delivery from the traditional fetters (and comforts) of employment. Many business analysts have argued that labor services will increasingly be supplied by free agents (for example, Orlov et al., 1999; Norris, 2000). However, I think it more likely that new labor market institutions will arise to mediate between firms and potentially distant workers. These intermediaries for the electronic

---

<sup>8</sup> I thank Michael Waldman for this observation. Equity concerns aside, winner-take-all markets may be an efficient means to distribute non-rival goods.

labor market will represent and in many cases directly employ skilled workers, vouch for their attributes, and resell their services.

On its face, the free agency model of future labor markets has plausibility. A variety of businesses have formed to leverage the opportunities for arms-length labor service delivery provided by free agents. Web sites such as MonsterTalent.com, FreeAgent.com, Guru.com, and SkillsVillage.com offer structured spot market or auction environments where companies can identify and contract with freelancers. These online services potentially serve a market-making function, permitting labor markets to operate where previously thinness of buyers and sellers, coupled with high communications costs, would have made transacting prohibitive. For example, one web-based service, Hotdispatch.com, hosts auctions where individual technical freelancers negotiate a price to answer single technical queries posted by individuals or companies.

There are, however, serious questions about the viability and reach of these markets. As the potential for geographically remote labor contracting expands, how will electronic labor markets deliver the “high bandwidth” data needed to foster good matches and mitigate adverse selection?

One answer may be standardization. If labor market transactions can be transformed into commodity purchases – for example, through development of detailed, verifiable skill certificates – then new forms of low bandwidth data may substitute for harder to verify high bandwidth data.<sup>9</sup> While this notion has merit, the intrinsic heterogeneity of workers and jobs probably places an upper limit on the reach of standardization to “commodify” the labor market.

An alternative – or possibly a complement – to standardization is more detailed information disclosure. Perhaps richer personalized online data could potentially convey the high bandwidth

---

<sup>9</sup> Lucking-Reily and Spulber discuss in this issue how tools to standardize heterogeneous transactions in electronic product markets are under development. Similar tools will appear in labor markets as well.

data that certificates do not. For example, electronic resumes may ultimately provide – in addition to credentials and experience – project portfolios, dockets of customer evaluations, and even standardized personality assessments.

As yet, however, there is little evidence to suggest that free agency is booming, and my suspicion is that it will not. As Orlov et al. (1999, p. 12) wryly observes: “Agent-driven [computerized] matching is to the hiring process what a dating service is to getting married – initial contacts are provided, but people still need to talk.” Data from the Current Population Survey’s Contingent Worker Supplements indicate that between 1995 and 1999, there was a small decline – from 6.7 to 6.2 percent of employment – in the ranks of independent contractors, independent consultants, and freelance workers. During the same interval, the share of workers employed by contract firms – companies that provide employees or their services on a contract basis – grew by 10 percent, and the share employed by temporary help firms grew 32 percent (Cohany, 1996, 1998; U.S. Bureau of Labor Statistics, 1999, 2000a).

It may be that in the very same highly credentialed technical and professional labor markets – those that appear to lend themselves most readily to free agency – high bandwidth in-person contact and firsthand knowledge are of great importance. If so, the growing geographic scope of the labor market will augment the demand for labor market intermediaries such as temporary help agencies (Autor, 2000b), service contracting firms, labor unions, and other hybrids. These intermediaries will offer several forms of high bandwidth data that are comparatively difficult for free agents to provide.

One function that intermediaries will serve is managing talent. While labor market services may be delivered by wire, in-person managers are likely to continue assisting, monitoring and motivating workers, as well as vetting the effort and quality of labor that they supply to (possibly

remote) clients. A second form of high bandwidth data that intermediaries may offer is reputation. Intermediaries may find it easier to build reputations than individuals, since collective (that is, firm) reputations are potentially more long-lived than individual reputations, are comparatively easy to verify, and appear to play an important role in clients' contracting and purchase decisions.<sup>10</sup>

A final form of high bandwidth data where intermediaries may hold comparative advantage is in credibly representing worker quality. Although electronic resumes could readily incorporate employer references and personality tests, this information is fraught with liability issues. It is a common perception that litigation has substantially diluted the value of written employment references, and I suspect it will have a similar effect in online markets. In contrast, intermediaries may face strong incentives (again enforced by reputation) to reveal and enforce worker quality.<sup>11</sup> Given these factors, I suspect that intermediaries possessing durable reputations will provide their imprimatur – at a price – to comparatively anonymous suppliers of labor services, and thus make arms-length labor transactions viable.

Labor unions, the most prominent U.S. labor intermediaries, are also likely to be affected. Unions have traditionally bargained collectively on behalf of a firm's workers but played only a small role in facilitating these workers' movements among firms. Current trends towards greater

---

<sup>10</sup> Banerjee and Duflo (2000) provide important evidence on the up-front costs firms bear to establish reputation. Bryjolfsson and Smith (2000) find that firm reputation plays an important role in Internet commerce, even in commodity purchases.

<sup>11</sup> Because the stakes are high and the threat of litigation credible, I do not expect the e-Bay customer feedback model (in which customers rate the performance of individuals sellers) to succeed in labor markets. Autor (2000a) presents evidence that the threat of litigation has substantially contributed to the growth of temporary help firms as a market intermediary.

outsourcing and worker mobility, in part facilitated by the Internet, may reverse these priorities. Intermediaries in increasingly fluid labor markets may need to assume more of a ‘talent agent’ role, representing workers as they move among firms, negotiating individually for wages and benefits, and offering services traditionally provided by employers. An example of such an organization is Working Today ([www.workingtoday.org](http://www.workingtoday.org)), which represents, lobbies for, and seeks benefits for independent contractors.<sup>12</sup>

## **Conclusion**

The broadening geographic scope of the labor market will generate new demand for both low and high bandwidth labor market data. The Internet will transmit much of the former, but the latter may not travel well by wire. This informational bottleneck will open opportunities for new institutions to emerge. While it is difficult to say precisely what these institutions will look like, their role is apparent. By supplying high bandwidth data to ‘grease the wheels of the labor market,’ they will make markets – reducing informational asymmetries that might otherwise thwart labor market transactions.

---

<sup>12</sup> Notably, labor unions have petitioned the International Commission on Assigned Names and Numbers (ICANN) to assign them a new top level domain called “dot union” (as in dot com).

## References

Abraham, Katherine G. and Susan K. Taylor, (1996). "Firms' Use of Outside Contractors: Theory and Evidence" *Journal of Labor Economics*, 14(3), 394 – 424.

Acemoglu, Daron, (1999). "Changes in Unemployment and Wage Inequality: An Alternative Theory and Some Evidence," *American Economic Review*, 89(5), December, 1259 – 1278.

Acemoglu, Daron, Joshua Angrist and David H. Autor (2000) "Substitutes and Superstars: The Impact of Electronic Commerce on Wage Inequality" work in progress, MIT.

Autor, David H. (2000a) "Outsourcing at Will: Unjust Dismissal Doctrine and the Growth of Temporary Help Employment," NBER Working Paper # 7557, February.

Autor, David H. (2000b) "Why do Temporary Help Firms Provide Free General Skills Training?" NBER Working Paper #7637, April.

Autor, David H., Frank Levy and Richard J. Murnane (2000a) "The Skill Content of Recent Technological Change: An Empirical Exploration" mimeo, MIT, July.

Autor, David H., Frank Levy and Richard J. Murnane (2000b) "Upstairs, Downstairs: Computer-Skill Complementarity and Computer-Labor Substitution on Two Floors of a Large Bank" NBER Working Paper #7890, September.

*Baltimore Sun* (1999) "College Applications Up Sharply, Partly Because of Internet Sites." March 6, Page 5A.

Banerjee, Abhijit V. and Esther Duflo (2000) "Reputation Effects and the Limits of Contracting: A Study of the Indian Software Industry." *Quarterly Journal of Economics*, 115, August, 989 – 1018.

Becker, Gary (1964) *Human Capital*. Chicago: University of Chicago Press.

Bleakley, Hoyt and Jeffrey C. Fuhrer. (1998) "Shifting in the Beveridge Curve, Job Matching, and Labor Market Dynamics." *New England Economic Review*, September – October, 3 – 19.

Bound, John and Harry J. Holzer (2000) "Demand Shifts, Population Adjustments, and Labor Market Outcomes during the 1980s" *Journal of Labor Economics*, 18(1), 20 – 54.

Boyle, H. Perry Jr., Lynn A. Summer and Benjamin Koby, (1999) "E\*Cruting: From Job Boards to MetaMarkets." Thomas Wiesel Partners, May.

Brophy, Beth "Playing the Early Decision Game Rules Vary from School to School – And it May Not be Right for You" *Business Week*, April 13.

Brynjolfsson, Erik and Lorin M. Hitt (forthcoming) “Beyond Computation: Information Technology, Organizational Transformation and Business Performance” *Journal of Economic Perspectives*.

Brynjolfsson, Erik and Michael D. Smith (1999) “Frictionless Commerce? A Comparison of Internet and Conventional Retailers” mimeo, MIT Sloan School of Management.

Brynjolfsson, Erik and Michael D. Smith (2000) “The Great Equalizer? Consumer Choice Behavior at Internet Shopbots” mimeo, MIT Sloan School of Management.

Burdett, Kenneth (1981) “A Useful Restriction on the Offer Distribution in Job Search Models” in *Studies in Labor Market Behavior: Sweden and the United States*, edited by G. Eliasson, B. Holmlund, and F.P. Stafford, Stockholm: Industrial Institute for Economic and Social Research

Computer Economics, (2000) “Resume Renaissance: Projected Number of Resumes from 2000 to 2003.” *Internet Marketing & Technology*, 6(7), July.

Cohany, Sharon R. (1996) “Workers in Alternative Employment Arrangements.” *Monthly Labor Review*, October, 31 – 45.

Cohany, Sharon R. (1998) “Workers in Alternative Employment Relationships: A Second Look.” *Monthly Labor Review*, November, 3 – 21.

*Economist* (1997) “Call Centres. A Nation of Telephonists” November 1.

*Economist* (2000b) “Labours Lost” July 13, 2000.

Frank, Robert H. and Philip J. Cook (1995) *The Winner Take All Society*. New York: Free Press.

Frazis, Harley, Maury Gittleman, Michael Horrigan, and Mary Joyce (1998) “Results from the 1995 Survey of Employer-Provided Training” *Monthly Labor Review*, June, 3 – 13.

Gaspar, Jess and Edward L. Glaeser (1998). “Information Technology and the Future of Cities” *Journal of Urban Economics*, 43, 136 – 56.

Gibbons, Robert and Michael Waldman (1999). “Careers in Organizations: Theory and Evidence.” In *Handbook of Labor Economics*, vol. 3, edited by Orley Ashenfelter and David Card, Amsterdam: North Holland.

Gordon, Robert J. (1998) “Foundations of the Goldilocks Economy: Supply Shocks and the Time-Varying NAIRU.” *Brookings Papers on Economic Activity*, 2: 1998, 297 – 333.

Greenwald, Bruce C. (1986) “Adverse Selection in the Labor Market” *Review of Economic Studies*, 53, 325 – 347.

ILogos (1999) “Internet Recruiting: Lessons from the Global 500,” May.



Katz, Lawrence F. and Alan B. Krueger (1999) “The High-Pressure U.S. Labor Market of the 1990s” *Brookings Papers on Economic Activity*, Issue 1, 1 – 65.

Kolko, Jed (1999) “Can I Get Some Service Here? Information Technology, Service Industries, and the Future of Cities” mimeo, Harvard University, 1999.

Kremer, Michael and Eric Maskin (1996) “Wage Inequality and Segregation by Skill” NBER Working Paper #5718, August.

Krueger, Alan B. (2000) “The Internet is Lowering the Cost of Advertising and Searching for Jobs” *New York Times*, July 20, C2.

Kuhn, Peter and Mikal Skuterud (2000) “Internet and Traditional Job Search Methods, 1994 – 1999” paper presented to the IRPP and CERF conference on Creating Canada’s Advantage in an Information Age, May.

Lang, Kevin (2000) “Panel: Modeling How Search-Matching Technologies Affect Labour Markets” talk given to the IRPP and CERF conference on Creating Canada’s Advantage in an Information Age, May.

Li, Charlene, Chris Charron and Amy Dash (2000). “The Career Networks” Forrester Research, February.

Moe, Michael T. and Henry Blodget (2000) “The Knowledge Web.” Merrill Lynch & Co., May.

Montgomery, James D. (1991) “Social Networks and Labor-Market Outcomes: Towards an Economic Analysis” *American Economic Review*, 81(5), 1408 – 1418.

Mortensen, Dale T. (2000) “Panel: Modeling How Search-Matching Technologies Affect Labour Markets” talk given to the IRPP and CERF conference on Creating Canada’s Advantage in an Information Age, May.

Myers, Marsha (2000), Cohens College Connection, personal communication, September 12.

Orlov, Laurie M., Stephen J. Cole , Andrew A. Reinhard and Liz Leyne (1999). “Skills Marketplaces Emerge” Forrester Research, October.

Pissarides, Christopher A. (1990) *Equilibrium Unemployment Theory* Oxford: Basil Blackwell.

Nakamura, Alice and Theresa Pugh (2000) “Internet Recruiting: A Background Report” paper presented to the IRPP and CERF conference on Creating Canada’s Advantage in an Information Age, May.

National Science Foundation (1998) “Science and Engineering Indicators, 1998” Washington, DC: National Science Foundation.

Nie, Norman H. and Lutz Erbring (2000) "Internet and Society: A Preliminary Report" mimeo, Stanford Institute for the Quantitative Study of Society, February.

Norris, Craig D. (2000) "The Project Economy," *The Industry Standard*, August 7.

Roane, Kit R. (2000) "Online Applications Revolutionize Admissions" *U.S. News and World Report*, 2000.

Rosen, Sherwin (1981) "The Economics of Superstars," *American Economic Review*, 71(5) 845 – 858.

Rosen, Sherwin (2000) "Labor Markets in Professional Sports" NBER Working Paper # 7573, February.

Spence, Michael (1973) "Job Market Signaling." *Quarterly Journal of Economics*, 87(3), 355 – 374.

U.S. Bureau of Labor Statistics (1999) "Contingent and Alternative Employment Arrangements" News Release, December 21.

U.S. Bureau of Labor Statistics (2000a) "Current Employment Statistics" accessed at <http://www.bls.gov>, September 19.

U.S. Bureau of Labor Statistics (2000b) "Employee Tenure in 2000" News Release, August 29.

Uchitelle, Louis (2000) "The Shifting Workplace," *New York Times*, July 24.

Verhovek, Same Howe (2000) "High-Tech Jobs Come to Logging Country," *New York Times*, August 21.

**Figure 1A. Worker productivity with strong technology-skill match**

<i>Technology Type</i>	<i>Worker Type</i>	
	<b>High</b>	<b>Low</b>
<b>General use</b>	<b>5</b>	<b>4</b>
<b>High-skill specific</b>	<b>8</b>	<b>0</b>
<b>Low-skill specific</b>	<b>0</b>	<b>6</b>

**Figure 1B. Worker productivity with weak technology-skill match**

<i>Technology Type</i>	<i>Worker Type</i>	
	<b>High</b>	<b>Low</b>
<b>General use</b>	<b>5</b>	<b>4</b>
<b>High-skill specific</b>	<b>8</b>	<b>0</b>
<b>Low-skill specific</b>	<b>0</b>	<b>3</b>