Is There A Shortage of Information Technology Workers?

by

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Abstract:

There has been a great deal of discussion about supply and demand conditions in the labor market for information technology (IT) workers. Industry representatives argue that there is a labor shortage while outside experts and labor market analysts see, at most, a temporarily tight labor market. From the IT industry, the recommendations about how to address the situation focus mainly on increasing the supply of IT workers, primarily through immigration and expanding college programs. I consider the merits of these arguments and conclude that some of the challenges facing the IT labor market have to do with issues concerning market adjustments, particularly lags in student responses to changing labor market conditions. But the most important challenges have little to do with overall supply and demand in the labor market. Instead, they relate to the management of IT workers inside companies. Specifically, the shortage of IT professionals that most employers see results, at least in part, from management practices that drive turnover from the industry, that result in misplaced recruiting, and that make it difficult to accommodate differences in contributions.

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What is a Shortage?

Employers and observers in the media routinely refer to shortages of talent in fields as diverse as politics and medicine. Economists in general rarely ever see a shortage. The explanation for this apparent disagreement turns on how one uses the terms and what is meant by them.

Economists study markets, and the function of markets is to equate supply and demand through market-clearing prices. In the world of perfect markets, there are never shortages, even for items that may be incredibly scarce. Consider, for example, the market for scarce and desirable commodities such as precious metals like platinum. Despite the fact that platinum is very scarce, there is no shortage of it: A consumer can essentially buy all of it that they want at the market price (buying a great deal will, of course, drive the market price higher). And this is the view that many economists have, a priori, of all markets.

The story gets slightly more complicated, however, when one thinks about the market for other items that do not so neatly fit the definition of a commodity and where information about them is less than perfect. If we think of another scarce good like a diamond, it is still the case that there is no apparent shortage, that consumers can buy as many as they want at prevailing prices. The difference here is that the quality of diamonds varies considerably and can only be judged by an expert’s inspection. In this situation, a buyer might well say that even though there is no shortage of diamonds, it does require considerable effort to find diamonds of good value, that is, those that are truly worth the price. The supply of good diamonds at a particular price may be more than enough to meet the needs of the buyer, but the buyer may still experience a problem with the market in that the costs of searching to find the good diamonds is reasonably high. To some extent, this is the situation that many IT employers are reporting: They find it difficult and time-consuming to locate employees with the mix of talent and skills that they want, even though they can do it. Employers sometimes describe such situations as a labor shortage because they find it difficult to identify the workers that they need. Economists, on the other hand, would say that while the supply was scarce, the real problem is that the search costs were high. But there was no shortage of labor at prevailing prices. If
there is a systematic problem in situations like these, it is that the employers lack the competency to search effectively.

Situations where both participants in the market and economists agree that there is a shortage of supply are those where the buyers, even after searching, cannot purchase enough of the items that they want even at the prevailing wage. In these situations, the market is not allowed to work. The most famous examples of such situations have been in wartime when various commodities, such as food or consumer products, have been rationed. Consumers would like to have purchased more butter or stockings at the prevailing prices, but the laws and rationing system prevented them from doing so. In modern memory, the best examples of this situation include gasoline shortages during OPEC price increases, where motorists with “odd” numbered license plates could only buy gas on one set of days and those with “even” numbered plates on the other days or in labor markets during periods of wage and price controls. While this is clearly not the case for all IT jobs and all IT employers, there are many, particularly those looking for software architects and sophisticated programmers, who would report that they are experiencing a shortage of applicants for these jobs exactly along the lines outlined above: They would like to hire more than they can find at prevailing wages, even after considerable search.

In the rationing examples above, it is clear why there is a shortage: Prices are not permitted to rise enough to equate supply and demand. In large measure, the decision to not allow prices to rise is a political one based on a concern about equity. Price rises would eliminate the shortage, but they would also shift the consumption of the scarce goods toward those who can afford to pay, leaving poorer consumers with nothing. This is not such a terrible situation for luxury goods like diamonds, but it is a much more difficult situation for more basic goods like food or gasoline.

But why we should find a situation like this in IT labor markets is much more puzzling. There is no legal rationing going on, no collective bargaining agreements or other restrictions on the market that prevent wages from increasing to levels that should equate even rising demand with scarce talent. In the absence of explicit restrictions on the labor market, the other explanation is the general appeal to market imperfections,
that something about the labor market is making it difficult for it to adapt. A survey of those arguments is presented below. They fall into two groups. The first focuses on the nature of supply and demand in the industry and considers specifically the question put forward by the IT industry as to whether constraints on the supply of labor are preventing the market from adjusting to what appears to be skyrocketing demand. The second, which I believe is much more promising, concerns the management of IT functions and IT labor in particular and the extent to which it is hampering the ability of employers to get the skills they need. I begin with the basic debate about supply and demand.

A Short Review of an Extended Debate:

No doubt arguments about the market for IT workers has been going on as long as there have been IT workers. But the contemporary debate began about three years ago with industry commissioned studies putting forth a dramatic story about the shortfall of IT talent. The major studies and their main arguments are summarized below:

- The first study, done by the Information Technology Association of America (ITAA), an industry association, by the Cato Institute, asserted that demand for IT workers was exploding while the supply was actually shrinking, at least as measured by college graduates with degrees and majors in IT-related fields. Further, the outsourcing of IT jobs – especially overseas -- was driven by difficulty in finding qualified workers in the U.S. In particular, the study surveyed a sample of large employers and claimed that there were as many as 190,000 standing vacancies for IT workers that could not be filled.²

- The second study, conducted by the U.S. Department of Commerce, made roughly similar arguments, focusing in particular on industry surveys showing that wages were rising from 7 to 20 percent for IT jobs between 1996 and 1997. But it also poked some holes in the previous

study, in particular noting that the supply of workers capable of doing IT jobs was much
greater than simply those with degrees or majors in IT fields.³

• A third study, this time by the Government Accounting Office, was critical of both of the
above studies, especially the Department of Commerce study, focusing on problems with the
data from industry sources and noting that government data did not show much evidence of a
labor shortage.⁴

• A fourth study conducted by independent labor economists for the U.S. Department of Labor,
represented a sweeping critique of all of the evidence for a labor shortage – changes in supply,
wage trends, projections about demand, etc. – and concluded that there was essentially no
evidence of anything but a tight labor market for IT jobs.⁵

• The industry responded with another study, this one conducted by Virginia Polytechnic
Institute for the Information Technology Association of America, reached essentially the
same conclusion as earlier ITAA study, this time based on a more representative sample of
employers who reported almost twice as many vacancies as before as well as other evidence
of a labor shortage.⁶

• From this point on, many other players weighed into the debate. Among the most interesting
are the Society for Information Management, an association of IT professionals, which
concludes that we are experiencing the worst labor shortage in the history of computing and
that it will get worse in the future⁷; Professor Norman Matloff, of U.C. Davis’s computer
science department, who argues that there is no labor shortage at all for IT workers and that
the problems that employers have relate to the fact that they prefer to hire young workers and

³ America’s New Deficit: The Shortage of Information Technology Workers,” U.S. Department of
⁴ There were actually two studies by the GAO on the same theme. “Information Technology Assessment of
the Department of Commerce’s Report on Workforce Demand and Supply,” Government Accounting
Office HEHS-98-106, March 1998 and “Information Technology Workers: Employment and Starting
⁵ Burt S. Barnow, John Trutko, and Robert Lerman. “Skill Mismatches and Worker Shortages: The
Problem and Appropriate Responses.” The Urban Institute, February 25 1998.
⁶ “Help Wanted 1998: A Call for Collaborative Action for the New Millenium.” Information Technology
Association of America and Virginia Polytechnic Institute and State University, March 1998.
⁷ “Addressing the Information Technology Workforce Shortage.” Chicago, IL: Society for Information
immigrants as opposed to more experienced workers because the latter are more expensive;\(^8\)
The Computing Research Association, a non-partisan group of research institutions, concludes that the data are not sufficient to tell whether there really is an IT labor shortage, although they see long-term concerns about the supply of IT workers for the industry;\(^9\) and the United Engineering Foundation’s study, funded by the Sloan Foundation, which concludes that “on the whole, there is no compelling evidence to suggest a national shortage of IT workers, either now or in the future.”\(^10\) The National Science Foundation has funded a study by the National Academy of Sciences to try to sort all of this out. The report is due in October 2000.

Making sense of these very diverse views begins with defining what jobs are in the IT workforce because different definitions can lead to different predictions. The most reasonable definition includes computer scientists, computer engineers, systems analysts, and programmers are the core of the IT workforce, although it is worth noting that these definitions are not used consistently and that different employers use different job titles for the same jobs, typically for software jobs. There were 2.2 million workers with these job titles in 1999.\(^11\) These jobs span everything from cutting-edge software firms like Oracle and PeopleSoft where new software is designed to the IT departments inside traditional manufacturing and service companies where employees maintain legacy systems. The labor market situation facing these different employers clearly differs. But it is possible to make some overall statements about the IT labor market.

The most obvious evidence of the existence of a shortage of IT workers would seem to rest with the above claims about vacancies, that jobs in the industry are going begging. While the absolute number of vacancies in these positions reported by the industry associations seems huge even in comparison to the

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\(^10\) United Engineering Foundation. “Assessing the Demand for Information Technology Workers.” IT Workforce Data Project: Report IV.
total number of jobs (as many as one out of every seven positions vacant), analyses suggest that the ratio of vacancies to positions has remained reasonably stable over time – the large absolute number of vacancies at present simply reflects the large number of jobs and not a change in the state of the labor market. Nor is it clear what those vacancies indicate about the state of supply and demand. They appear to include positions currently staffed by contractors and temps which makes it less obvious that they represent a shortage of labor per se. Because vacancy data is not typically reported by industry, it is not clear how this level of vacancies compares to other industries – is it a lot or a little? Jobs with high turnover, for example, also show a high number of vacancies at any given time, which is why many observers believe that the average length of time required to fill them greater or less than elsewhere is a better measure of the difficulty in finding labor.

**Wages.** Another promising, overall measure of the state of the IT labor market is changes in wage levels. Rapidly rising wages are an indication that the market is adjusting to a relative shortfall in supply, reflecting scarce supply. And while even rapidly rising wages do not necessarily suggest an overall shortage, it is fair to say that the labor market may be out of balance while those wages are adjusting, especially if the adjustments are big and fast. Certainly median earnings are higher for IT jobs than for most, although for much of the 1980s and into the 1990s, they were actually falling in real terms (see below). They have been rising reasonably fast since 1995, about 10 percent per year. On the other hand, those increases are roughly parallel to those of other professional jobs and for those with specialized degrees.13

Surveys of government wage data uniformly suggest that while wages are rising for IT workers, they are not exploding; private sector surveys of IT employers, on the other hand, typically show considerably greater wage growth. One explanation for the disparity between employer surveys and complaints and government wage data is that the private sector surveys are flawed as compared to the government data, and no doubt the private data does come with complications, especially with respect to its

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11See “Core Occupations of the US Information Technology Workforce. IT Workforce Data Project: Report 1, United Engineering Foundation, January 1999 for an extended discussion as to job titles in this industry.
12See “Assessing the Demand for Information Technology Workers.” United Engineering Foundation IT Workforce Data Project, Report IV.
representativeness. Another explanation is that the government data does not include other components of pay, such as bonuses, profit-sharing, and stock options, which apparently have doubled in value since 1994 and now account for approximately 10 percent of all compensation. Stock options, which get the most attention, have paid off handsomely for some IT workers: more than a quarter of IT employees had options worth more than $10,000 in 1998. But the median value of options across the IT workforce appears to be zero. There is also evidence that employers are rewarding star employees in ways other than compensation. Giving away BMWs seem to be the current fad as part of recruiting bonuses. Why employers are giving cars rather than cash, which would by definition offer more utility to more employees, is an issue explored below. There is also evidence even from the private surveys that salary increases may have leveled off. The percentage increases in 1999, for example, were roughly the same as in 1998. Wages also adjust rapidly to changes in supply and demand within the IT workforce. For example, SAP programmers were in first place in the salary rankings of IT professionals in 1998 but fell to sixth place 18 months later as demand for their skills fell relative to others occupations.

The evidence about rising salaries seems more convincing of an imbalance in the labor market than that about vacancies. That evidence points toward a sharp, albeit recent shift from a situation of an excess supply of labor pushing wages down through the mid-1990s to one of excess demand since then. The picture certainly points toward tight labor markets, although whether they will continue to be that way is not clear. To address that question requires a more direct look at the supply and demand picture for IT jobs.

**Supply Issues:** Most of the arguments suggesting that we are experiencing a severe shortage of IT workers begin with the notion that we do not have enough workers with adequate skills to do the work. Arguments that more science and engineering Ph.Ds are needed to help the economy prosper have been common for years, but the evidence suggests a much more mixed picture. Projections indicate, for example, that more than a fifth of these Ph.Ds will not find adequate employment, although it is fair to

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14 Barnow et. al. survey the various sources of information about wages and draw this conclusion.
15 United Engineering Foundation, “Assessing the Demand for Information Technology Workers.”
18 Computerworld “Mid-year Salary Survey” March 29 1999.
say that the situation varies enormously across fields and changes rapidly. The United Engineering Foundation study reviewed prior projections and assertions about skill shortages in technical fields and concluded that “in all these years, there is no evidence that any serious shortages of technical professionals – engineers in the past, information specialists now – have ever occurred.” 20 To some extent, the arguments about the need for more skilled and educated technical workers seem to be of the “chicken soup” variety: It couldn’t hurt. These workers seem to be key to the success of companies and the economy, so having even more of them might help.

But how about the supply of IT professionals, specifically? The view even as late as the mid-1990s was that there was an *oversupply* of IT workers, especially for the high-end jobs, 21 a view that changed dramatically, at least from the industry’s perspective, by 1997. Perhaps the most persuasive fact in the argument that the supply of these workers was inadequate was the evidence reported in most of the industry studies suggesting that the number of graduates with degrees and majors in IT fields was actually declining through the mid-1990s. And indeed it was. There were several challenges to the conclusion that this situation represented a decline in the supply of IT workers, however. First, the amount of course taking in IT areas overall did not seem to be down, even if IT majors were. Non-majors were taking a great number of IT courses, and courses that were not explicitly about IT often contained a fair amount of IT-related content (data base management content in business programs is but one example). 22 Second, the supply of workers able to do IT work is far greater than those with degrees in IT fields. Only about half of IT professionals have even bachelor degrees in an IT-related field, and only about 10 percent of individuals in programming positions even have a bachelors degree of any kind! 23 On the other hand, the importance of non-degree, technical credentials in the IT field is absolutely exploding and, some argue, may be an even

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23 United Engineering Foundation, “The Production of US Degrees in Information Technology Disciplines.”
more important source of IT skills than higher education in that they convey more about the practical skills that employers care about than do academic degrees. The major accrediting organizations in the work of information technology, many of whom are IT companies like Cisco Systems and Microsoft, have already awarded more than 1.7 million credentials certifying skills to individuals in the workforce.\textsuperscript{24} And, of course, these credentials do not include those workers who have skills but have not had them evaluated and certified.

Finally, the number of students majoring in IT-related fields has rebounded sharply in the last three years. The Computing Research Association reports that enrollments in computer science programs (only one part of the IT academic spectrum, albeit a crucial part of it) rose by 5 percent in 1995-'96, but then 40 percent the next year and 39 percent in 1997-'98.\textsuperscript{25} Most observers believe that this rapid increase in enrollments is due to the attractive job opportunities in the IT field. Proponents of the view that there is a labor shortage in IT are inclined to interpret this response as evidence that there must currently be a surplus of openings/a shortage of takers, and that is what has draw the attention of the next generation of workers to these careers so quickly. Opponents interpret it as evidence that the labor market is adapting to high wages and, therefore, there cannot be a shortage. But the more important story concerns the way in which supply is adapting, a model sometimes referred to in economics as a “cobweb” cycle for the path it traces out across the supply and demand functions on a graph.

Harvard economist Richard Freeman demonstrated this model in the context of the engineering profession. High wages attracted lots of students into the field who then helped increase labor supply and depress entry-level wages four years later when they entered the labor market. Lower wages then depress the number of students entering engineering programs leading to the reverse situation four years later. The factor driving this model, of course, is the fact that labor supply adjusts to current conditions with a time lag. Under typical conditions, these perturbations eventually settle down to a long-run equilibrium. One situation where they do not is when demand experiences exogenous shocks, causing it to rise and fall rapidly over short periods.\textsuperscript{26}

\textsuperscript{25} These data are available in Freeman and Aspey, Chapter 5, along with a detailed analysis of the sources of supply for IT workers.
The IT labor market exemplifies the situation where exogenous shocks in demand continue to disturb the labor market. In the late 1980s and through the early 1990s, there was rather dramatic downsizing of IT departments that followed a period of rapid growth. Some part of the downsizing was no doubt linked to the general downsizing and restructuring of firms that cut jobs away from staff and headquarters positions. But some part of it was targeted directly at IT. It related to the difficulty that companies had in managing IT and the conclusion that, for most of them, IT was not going to be a part of their core competency. Research by the Economic Policy Institute found that real wages for college graduates entering IT jobs reached a peak in 1986 and then began to decline, coinciding with the downsizing of IT departments. The downturn in the number of college students in IT programs roughly coincides with the decline in real wages, with a time lag as current students complete their degrees and new students enter with a different course taking pattern. Entry-level IT wages have been rising for the last few years, although only in the last two years or so have they gotten back to their level in 1986. The increase in students pursuing IT education roughly coincides with these rising wages.\(^\text{27}\) And the number of entry-level IT workers from higher education programs should begin to rise rapidly as these new graduates enter the labor market. What happens then, whether there could even be an oversupply of labor, a settling down, or a continuation of boom-and-bust, will depend on whether demand continues to jump around.\(^\text{28}\) This cobweb-like adjustment process in the labor market is inevitable where labor supply draws heavily on entry-level, college graduates and where demand fluctuates wildly. It does represent a situation where the market, working on its own, is not neatly and smoothly allocating labor.

**What About Immigration?** In addition to training in U.S. degree and certificate programs, immigration provides another source of skills for IT employers. The method of entry into the U.S. IT workforce is for foreign nationals to come to college in the U.S., then apply for a visa, and finally to secure permanent status.\(^\text{29}\) Seventeen percent of the IT workforce in the U.S. are foreign born. Of those, one-third

are under the age of 30 (as opposed to 22 percent for the overall IT workforce) and 40 percent have graduate degrees (as opposed to 15 percent for the native-born IT workforce).  

There is little doubt that immigration has helped staff the U.S. IT workforce. The policy debate, of course, is whether immigration should be expanded to address the growing demand for IT workers, but a prior question might be to what extent immigration has actually addressed that issue so far. A review of other occupations where immigration was seen as a solution to labor shortages, such as nursing in the 1980s, suggests that the effects were mainly noticeable in a few regional markets, as opposed to improving the situation across the relevant labor markets, and that the main effect may have been to delay the search for more fundamental solutions.  

The government’s own account of the H-1B Visa program through which most foreign IT workers come to U.S. employers, suggests that it is not effective at meeting urgent, short-term labor demand and that it functions more as a probationary program to try out workers before they become part of the permanent, U.S. workforce. Seventy-six percent of H-1B visa applicants, for example, were already working in the U.S. when they applied. If immigration does not, in fact, respond to short-run fluctuations in demand, then the rationale for it must change. The question as to the actual effects of immigration is too complex to address in detail here. But it would seem that a rationale based on bringing in top talent (which is what industry proponents often assert) makes more sense to justify immigration than an argument that it helps meet peaks in demand. It is worth noting that if immigration responds to changes in demand with a lag, it would actually exacerbate the cobweb problem noted above.

Demand Issues: Among employers, software clearly seems to be the area of greatest concern and programmers the occupation most in demand. But, interestingly, the actual growth in IT jobs since 1983 has been weakest for computer programmers – virtually flat – as compared to computer scientists and analysts which have had the most growth. And the projections for employment growth show that programmers will have the lowest rate of growth through 2006 of the major IT occupations. How can this be reconciled with the fact that employers are focusing their concerns about a labor shortage on software

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31 See Freeman and Aspray, op. cit., p.22.
and programming jobs in particular? Part of the explanation is that programming makes up far and away
the largest number of jobs in the IT area, more than 10 times the number of other occupations -- so that
even though the percentage increase in these jobs is the smallest, the absolute number of new jobs projected
for programmers is the greatest. There are lots of jobs to fill even if the number is not necessarily growing.

But the more promising explanations turn on a more sophisticated understanding of the nature of
programming work. For example, turnover of programmers is especially great as compared to other IT
occupations. The number of openings that result from employees leaving the programming occupation
exceeds the number of net, new positions.\textsuperscript{34} To illustrate, the National Survey of College Graduates finds
that while 52 percent of civil engineering graduates are still in that field 20 years after they graduate
(typically in their early 40s), only 19 percent of computer science graduates are still in that field 20 years
later.\textsuperscript{35} In the area of computer programming, 36 percent of all graduates with majors or degrees in that
topic have left that field and are working in other occupations.\textsuperscript{36} A study by George Mason University
found that IT workers overall were twice as likely to have changed careers as were those in other
occupations.\textsuperscript{37} This suggests that turnover may have something to do with the concern about finding an
adequate supply of new programmers. And that may have something to do with the management of those
employees (see below).

Similarly, and arguably most important, the demand may not be across-the-board for all IT or even
for all programming jobs. A recent survey by the industry group ITAA, for example, found the firms
responding that they have more programmers than they can use.\textsuperscript{38} Other employers report that the real
demand, and the real shortfall, is for a relatively small group of the very best and most qualified
programmers.\textsuperscript{39} To the extent that this is the case, it represents a very different story than the account
typically presented of an overall shortage of employees.

\textbf{A Partial Conclusion.} A summary of the above finds no evidence suggesting that there has been
or will necessarily be a long-term shortage of IT workers. There certainly have been temporary imbalances

\textsuperscript{34} Ibid.
\textsuperscript{35} Reproduced in Matloff, p.36.
\textsuperscript{36} Veneri, op. cit.
\textsuperscript{37} This study is reported in Karen Cangero. “Where are the Workers? Part One. The IT Staffing Shortage.”
www.Intraware.com/ms/mktg/indaa/itkac/skilledwrks.html
in the supply of and demand for IT workers and very tight labor markets. These imbalances have been
driven by rapid changes in the demand for IT services and the lag with which supply adjusts. Overall, the
labor market in the IT area seems to be working in the sense that supply and wages are adjusting to these
swings in demand, although one could say that the past 15 years have represented almost a constant period
of rapid adjustment – from boom through the late 1980s to relative decline through the mid-1990s back to
boom again. It also seems clear that if there continue to be swings in demand, we will continue to see
imbalances in the market. We see these imbalances continuing within the IT labor market as well,
particularly for programming languages, as the demand spikes for new languages and falls for old ones.

But the industry representatives also have a point in asserting that there are problems in the labor
market, especially problems meeting demand. Labor markets adjust in part because employers adjust their
demand to changing prices, and the swings in price have been happening so fast that the usual
accommodations to tight labor markets have not had time to happen. A typical response to rising prices is
to find substitutes for the expensive items. In the early 1980s, for example, there was a real shortage of
IMS programmers and rising wages, a situation that continued for many years. IBM worked on the
problem by creating relational database systems to substitute for IMS programming, and it was so
successful that the demand for those programmers essentially vanished. One could argue that new
programming languages and demands have been coming and going so quickly that the industry has not had
time to develop the usual prepackaged solutions that would substitute for code writing and a lot of
specialized programming labor.

Even though there is no evidence of an overall shortage of IT workers, the fact that the supply of
new workers responds to changes in demand with a reasonably long lag (especially given the fast pace of
demand changes) exacerbates imbalances in the labor market and represents a real problem for the industry.
This issue may well be the strongest argument for policy action. But before reaching the conclusion that
policy interventions are needed, it would be worth understanding why the industry relies so much on entry-
level college graduates for their labor supply and whether that is inevitable, an issue examined below. The
conclusion above that most vacancies in programming are caused by turnover seems especially worth
pursuing.
Finally, market adjustments may be interpreted differently by individual employers than by the market as a whole. For example, an employer may find that it cannot hire the workers it needs because it cannot afford to pay the new, higher wages that scarcity has produced. From the perspective of an individual employer, this situation looks like a shortage: It can no longer find workers at the wages they have been paying. It is also a crisis for them. From the perspective of the economist and perhaps even of the industry, there is no shortage, just higher wages. And when the above employer cannot hire, it simply reduces demand, helping to adjust the market. Why individual employers have such a hard time adjusting to rising prices – in particular, why an unusually large part of the demand for new hires is focused on a few key workers where bidding wars are common – seems worth considering in detail.

The Management of the IT Workforce

The arguments above suggest that a large component of the problem that IT employers report in finding adequate workers may be related to factors other than the labor market, and those other factors focus heavily on the policies and practices for managing IT workers. A good place to begin is with hiring decisions.

The Hunt for the Best. The evidence that IT employers are focusing their job search disproportionately on the best applicants seems very powerful. Professor Matloff’s study examined the hiring practices of the largest IT employers, particularly software companies, and found that these employers limited their recruiting of new applicants to a small number of elite schools, typically from 10 to 20, which tend to be the same schools for all the companies. Of those who apply for jobs at those companies, only about two percent receive job offers. A low percentage like that is not necessarily an indication of a picky employer and may be attributable to large numbers of unsolicited, unqualified applicants. But he also examines the ratio of offers extended to applicants who are interviewed by these companies. Any reasonable recruiter screens-out entry-level candidates who lack the basic requirements for jobs before interviewing them. The companies also know that because the choice applicants who they interview are likely to receive many job offers, they need to extend several offers to be certain of one acceptance. Yet only one in four applicants interviewed receives an offer. This would seem like a relatively low number if there really was a dramatic
shortage of qualified applicants. Further, virtually every study finds that the job requirements posted for positions are so demanding and seem to describe such perfect candidates that they are unlikely to exist.\textsuperscript{40}

Why are employers so picky? Employers report that because the starting salaries are so high for these jobs, they feel that it is necessary to raise the standards for hiring in order to be sure that they are getting their money’s worth from the new hires.\textsuperscript{41} This appears to be a common response, but it is an extremely odd one given the usual view in human resources that wage rates follow from job requirements, not the other way around.

From the employer’s perspective, the reason they are so concerned about finding the best employees is because they really do matter. Research on the performance differences among programmers, for example, finds that the best programmers in an organization are at least ten times better than the worst ones, and some studies put the disparity even higher, at 20 times or more.\textsuperscript{42} The reports from employers in the industry consistently indicate that they would like to hire more of these workers than they can find. This statement represents the classic definition of a shortage described above: At a given price, buyers are willing to purchase more than in available.

Avron Barr and Shirley Tessler, who run the Software Industry Study at Stanford University, suggest that, at least at the leading companies, management believes that the key to developing the software competency of their firm is simply to bring in more capable employees, not necessarily to manage them better.\textsuperscript{43} Professor Denis M.S. Lee, who studies work issues associated with hi-tech employees, observes that virtually all of the management efforts with respect to IT workers are directed at getting them in the door.\textsuperscript{44} In other words, because all they are doing is recruiting, and that has to meet the needs usually served by a range of management practices to motivate workers and get jobs done, they had better really work at it. Whether this makes sense or not is an issue I return to below.

\textsuperscript{40} See, e.g., Weinberg, op. cit.
Are Older Workers Losing Out? One of the striking issues in discussions about hiring IT workers is the perception that employers are not interested in hiring older workers. Professor Matloff’s study is perhaps the most vocal on this point and is full of detailed anecdotes about qualified senior workers who cannot find jobs, despite the apparently tight labor market. Many of the other studies of the IT labor force situation also contain stories about employers’ preferences for younger employers and, in some cases, actual practices to secure that result. There is other evidence as well. For example, an Information Week survey of IT managers found that only 2 percent of them reported that they would hire a worker with more than 10 yrs experience. Another survey, this one by Network World, found that only 13 percent of the respondents age 20-30 said that they would hired anyone over 40, and 47 percent of the entire sample had never hired anyone over age 40. The returns to greater experience in the IT workforce have actually been declining over time, suggesting the greater experience is less valued now. And there is evidence that, while the unemployment rate is quite low for IT workers, the duration of unemployment has been rising since 1998. This would be consistent with the view that older workers, who are the most likely to be unemployed, have been experiencing a harder time finding new jobs. Among electronic and electrical engineers who were laid off, a group that may only partially map onto the IT sector, only four percent reported that it was fairly easy to find a new job in the tight labor market of 1998, 76 percent thought that age was an important hindrance to their job search, and older respondents reported significantly more difficulty in job search.

The view that IT work and software programming in particular is a young person’s game seems to be remarkably common in the industry, especially so given that any behavior consistent with that view appears to violate age discrimination laws. The explanations as to why this perception exists include the following:

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45 See, e.g., Kathy Koch. “High Tech Labor Shortage.” Congressional Quarterly April 1998, which reports managers giving directions to only hire recent grads because they are willing to work longer hours.
47 Neal Weinberg. “Career Crisis.” Network World. September 1998 p.14. The article also reports data from the National Science Foundation indicating that the average age of IT professions has risen slightly over the past decade.
• Older workers, particularly those with families, cannot or will not work the punishing hours that are typical in software.

• Older workers may not have the skills that are most current. To the extent that the skills are learned in traditional post-secondary education programs, this may be the case, although there are many other ways to learn these skills, and one would think it would be easy to check.

• Younger IT managers find it difficult to manage older workers or at least are fearful of trying.

• Older workers may demand more money than younger workers to reward their experience. Yet the experience may not be worth much.

Paradoxes in a Tight Labor Market. The arguments above raise some intriguing questions:
* First, if there really is a shortage of IT workers and wages are exploding, why is it that a disproportionate number of them are leaving the field for careers elsewhere, particularly in programming where the focus on a labor shortage seems most intense?

* Second, if employers are having such a hard time finding qualified applicants, why are they all looking in the same place for the same workers – why don’t some employers look more broadly in less-intensively searched applicant pools where greater investments in search might yield better returns in the form of lower-priced talent?

* Third, if it is particularly difficult to find highly qualified applicants, why have job requirements apparently been escalating?

* Fourth, if there is a shortage of talent, why is it that more experienced workers seem to be having a more difficult time finding IT jobs?

A Critical Assessment of IT Management. The place to begin understanding the management of the IT workforce is with the organization of jobs. In brief, aside from pay, many IT jobs but especially computer programming jobs would qualify as lousy jobs. Most of the understanding about how to design work to meet the psychological needs of workers seems to have bypassed the IT professions. In many
organizations, IT work began in previous decades as relatively low-skilled work, especially simple jobs like data entry. The culture of these operations remained the same. (Some observers believe that computer operations remain in the basement for a reason.) They are seen as a cost center, not a source of competitive advantage. As software grew more complicated, managers got better at breaking up programming into distinct components where code writing could be assigned as small, disconnected projects that were outsourced or assigned to individuals who worked in isolation from each other.

This approach to work organization violates basic principles of job design by creating narrow tasks where workers cannot tell what the overall goal is. While enlightened workplaces were moving toward teamwork that helped build social relations, programming was moving in the opposite direction with work systems that isolated employees. Where other organizations were empowering employees to take on large, unbounded projects, programming was assigning self-contained and highly defined tasks with tight performance parameters. The results of programming jobs are rarely acknowledged or even understood outside of the immediate programming area, and programmers often do not even learn how their work went (except for mistakes, which they hear about immediately). Sociologist Stephen Barley has written about the fact that technical work of all kinds is undervalued and under rewarded by most corporate cultures.50

Breaking up projects into separate, individualized packages also creates considerable time pressure as each individual project has to be coordinated with others in order to get systems completed. Research into job design for IT work shows that IT areas are poorly integrated into the rest of the organization, and IT workers as a result do not learn much from the organization.51 Poor job design is one of the main drivers of turnover,52 and there is every reason to believe that the same relationship applies for IT jobs.

As Denis Lee observes, pay is not as big a motivator as interesting work for most IT workers. Challenging work, job rotation, mentoring, and work-based support might well be the most cost-effective interventions. Yet few employers spend resources to help their IT workers develop and function on the job,

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and most confine their management efforts to pay. Alternative methods of organizing work appear to conflict with the dominant model of organizing IT work and with the IT culture, which transcends organizations. In addition, IT jobs have traditionally suffered from the same limited career paths as do other technical jobs: A good programmer might aspire to head the IT area but not areas outside IT. To get ahead, they may feel the need to change occupations.

With respect to hiring, as Tessler and Barr observe, most employers don’t know how to hire the right people. Most employers understand, as noted above, that good programmers in particular are massively more productive than poor ones, but predicting in advance who those are is difficult. Denis Lee reports that the most important factor in job performance for these workers is interpersonal skills, something that few employers seem to consider. Other research indicates that general talent and energy predicted job performance better than programming language experience, by a factor of about four times! In fact, the latter was the worst predictor (in fairness, some level of programming language experience is probably a given in securing these jobs). So in the absence of a good understanding as to what predicts job performance, employers rely on credentials, especially academic credentials, which are highly visible and easily contribute to bidding wars among competitors. Yet college academic credentials, such as grades, predict almost nothing about subsequent job performance.

The focus on college credentials helps explain some of the problems reported with IT recruiting. Employers know the best workers are really worth getting and seem willing to pay more to get them. But they also have to base their pay on the expected value that a new hire will contribute. Because they are not very good at predicting who will be one of those star employees, they have to set pay based on the average expected performance. Although employers may not feel this way, they are quite probably underpaying their best applicants – dramatically so – and overpaying their poor ones. They just cannot tell which is which. An employer who could do better at judging talent would have no difficulty attracting the very best workers because it could afford to pay them substantially more.

53 Denis M.S. Lee, 1999, op cit.
When those pay rates become seen as the market rate, the human resource departments build more and more credentials into the job descriptions as a way to screen out the poor performers. An alternative might be to hire more programmers who perhaps are not so qualified and pay them much less. Industry experts would point out that some important tasks simply demand the very best skills because the difference between excellent and average solutions may be enormous. No doubt this is true for software design and architecture jobs, although arguably most software jobs do not fall into that category. But the problem, noted above, is that employers have a hard time telling who has the best skills. Further, as Tessler and Barr argue, is that some employers have a hard time identifying which programmers are good even after they are on the job.56

Arguably the more important difficulty with sorting out talent comes not even with the difficulty in recognizing performance but with the inability to treat employees differently. The research noted above showing that the best programmers are more than 10 times better than the worst also finds that the differences in pay associated with those performance differences are only 10 percent – that is, the best worker receives only 10 percent more than the worst but is ten times more productive. It is difficult to imagine that any human resource systems currently used by IT employers would allow programmers doing similar work to have earnings differences equivalent to these performance differences – factors of 10.

The inability to measure and then differentiate performance may also explain some of the prejudice against older workers. The assumption that older workers, especially those with families, cannot or will not work the same long and unstructured hours as new hires may be true. But if employers could accurately measure performance, then hours of work would not be used as a proxy for productivity. And if they could assign proportionate rewards, even differences in productivity could be accommodated: A worker who got only half as much done might only be paid half as much. If the performance measures were valid and pay was clearly linked to performance, such differences would not conflict with age discrimination laws even if wages did end up being significantly less for older workers. Here again, the main challenge might be whether a system where compensation could conceivably decline with experience could be tolerated by contemporary human resource arrangements.

The most difficult challenge facing the management of IT workers, however, may not be managing the differences in performance between employees doing the same work. It is handling the change in performance for individuals whose programming skills become obsolete. As many observers have noted, programmers can easily become obsolete when the programming languages that they know fall out of favor. These languages are very different and do not necessarily build on each other. And they change very quickly. A senior programmer working in a language that is no longer “hot” may literally be less useful to their employer than a new hire, in some cases worth nothing at all, and a system that matched compensation to productivity swings like that would be difficult to imagine.

The typical solution to the situation above has been to get rid of the old programmers when their languages fall out of favor and hire new ones. This helps explain some of the high turnover in the field. The alternative to this arrangement, retraining the workers, faces real challenges especially in less sophisticated organizations where they cannot easily foresee the changes in languages – it is too late to retrain -- and in smaller ones where they cannot afford the retraining. Most employers are reluctant to make the investments in retraining in any case for fear that the workers will leave and take the skills with them or, even if they stay, that the demand for the skills will not remain long enough to make the investments worthwhile. The lack of retraining exacerbates imbalances between supply and demand when markets shift because employers have to wait for employees to train themselves in the new skills, typically waiting for the next generation of graduates.

The above arguments also explain two important trends in the structure of the industry: The rise of outsourcing to IT consultants and the success of start-up companies as a mode of operation. Outsourcing IT projects is attractive because performance and cost can be more easily linked: Companies contract for a given result at a given price, something that they cannot achieve internally because they cannot measure and reward performance accurately. Consulting companies can make this happen because they have a competency at managing IT workers, which they have developed over time through considerable investments and out of necessity. Companies like Andersen Consulting are also good at managing and developing IT workers, and they do it using the methods noted above that most other IT employers ignore;

57 E.g., Freeman and Aspray, p.68.
training, mentoring, teamwork, etc. And they also have a competency at measuring individual performance and rewarding employees in relation to it. The larger consulting firms in particular have the ability to foresee changes in skills far enough in advance to make retraining pay off. Employees are more likely to stay with employers with whom they believe their skills can be kept up to date, and this increased retention helps make skills pay off.  

Start-up IT companies are a successful organizational form for similar reasons, albeit achieved in very different ways. Their job design is much better, albeit not always intentionally. Because the organizations are small, there is little hierarchy and structure, and the work gets done in natural teams; the organization understands that software performance is key, and good jobs are recognized and rewarded; programmers have a stake in the organization (in terms of status and potential rewards) that they typically cannot in larger, more bureaucratic organizations, and stock options make it possible to reward performance differentially in proportion to contributions.

**Recommendations and Conclusions**

Employers clearly are right in pointing out that they have real problems finding the IT talent that they need. Most employers are finding the labor market is tight for all jobs, especially for IT jobs, and this drives up search costs and wages. They are also finding that adjusting to the rapidly changing labor market is difficult, in many cases leaving them with few reasonable options. In some cases, individual employers do experience what appears to them to be a classical labor shortage – they cannot hire enough workers at the prevailing wage. It is also fair to say, however, that the attention given to recruiting is disproportionately focused on a very few jobs. If there is a crisis in the IT labor market, it is a narrowly focused crisis.

The belief that the cause of this situation is some inherent shortfall in the supply of IT workers is misplaced, however. The supply of college graduates trained for IT careers has been very responsive to market conditions. The one complication with that supply, however, is that it lags demand by several years, and that lag, combined with swings in demand, creates real problems for the labor market. Solutions

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58 There are solutions to the problem of worker retention, such as training contracts that require training investment to be paid if the workers leave, but not necessarily to the problem that the need for the new skills may not last long.
that focus on labor supply – condensing college experience, expanding immigration – seem premature until other, more obvious issues are addressed on the demand side. These include understanding why turnover is so great in IT jobs, especially in programming, why employers rely so heavily on recent college graduates to supply these key jobs, and why it appears relatively difficult to recycle experienced workers.

The answers to these demand-related questions all focus on management practices. And while it may be unreasonable to expect individual employers to address and solve these issues by themselves, the fact that at least some IT employers appear to have success with different practices indicates that it is possible to make progress. Steps in the right direction would include:

1. Getting better at recruiting. Employers would be better served channeling some of the resources and energy currently going into bidding wars directed at a small number of applicants with elite academic credentials toward a systematic effort to predict which employees will succeed. More accurate predictors of success would allow them to expand the pool of talent considerably. The state of expert knowledge in this area already dramatically exceeds typical practice.

2. Change the design of IT jobs, especially programmers, to reflect their real contribution to the organization. The poor organization and treatment of employees in these jobs appears to contribute significantly to high turnover and higher compensation costs, given that pay effectively substitutes for the lack of other positive job attributes. Again, knowledge about how to make these changes is widespread in other industries.

3. Measure performance better and tie rewards to performance. If star performers really are the key to this industry, then efforts to identify who the stars are and then reward them proportionately will save money in the long run. Better performance management may also reduce the prejudice against older workers that is virtually institutionalized in the industry. Adapting human resource systems so that they can reward employees according to these performance differences will be the real challenge.

59 The relationships between retention and training are described in Peter Cappelli. The New Deal at Work:
The strongest argument for policy intervention comes in the area of retraining. Skill requirements in this industry are reasonably unique in that they change quickly and often do not build on each other. Skill obsolescence and the lack of retraining explains a large part of the turnover in the industry, the focus on recent graduates to fill jobs, exacerbating the labor market imbalances noted earlier, and the difficulties that older workers often experience. Retraining would address many of these problems. It is one thing to ask large employers to retrain their employees because they have the ability to forecast skill demands and the resources to both manage the investments and make use of them after. It is another to ask smaller employees to take on that responsibility.

Given the individualized character of the IT labor market at present, the best solutions to the retraining issue are likely to be ones that assist individual employees in keeping their own skills up to date. Post-secondary education institutions already play an important role in retraining IT workers, and innovations in financing these arrangements also help, as in California where workers can draw on unemployment insurance funds before they are laid off. A thorough discussion of policy interventions with respect to retraining is clearly beyond the scope of this paper. But retraining appears to be the labor market issue that is both most likely to improve other aspects of IT labor market problems and least likely to be solved on its own.