

What Shortages? The Real Evidence About the STEM Workforce

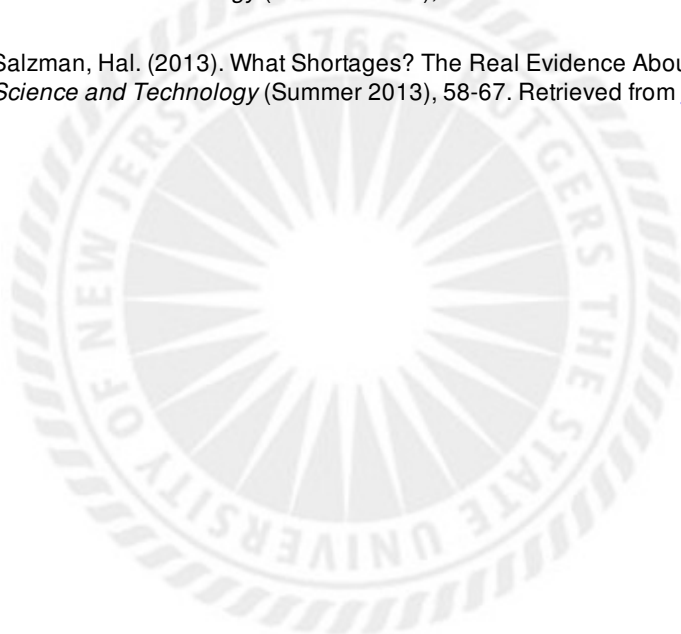
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What Shortages?

The Real Evidence About the STEM Workforce

Despite naysayers, the nation is producing more than enough quality workers in scientific and engineering fields—and policymakers and industry leaders should proceed accordingly.

Computer science graduates in 1998 often looked to Microsoft as the hottest employer in town—and as it turned out, for good reason. Within four years of joining the company, they would be part of a team that ushered in an operating system used the world over and become millionaires along the way. By 2002, a future with the company brought a good salary (but not instant millions) and membership on a team that not only could not develop the next New Thing but couldn't match the achievements of its competitors.

Middle age had crept up on Microsoft and other information technology (IT) companies just a quarter century after the dawn of the microcomputer era. Established IT companies found that they could no longer attract the young, bright, hot graduates from the top universities, who instead flocked to new startups. Feeling the panic of rapidly rising salaries during the dot-com bubble and seeing the young

upstart companies lure away the best talent, the IT industry worried about where it would find its future workforce. And thus began the drumbeat of “talent shortages,” supported by a cascade of reports and echoing such cries of earlier decades, but attached to the broader fears of a nation that thought it was losing its dominance in the world.

Today, most policymakers and industry leaders are united in their belief that the United States faces a high-tech talent crisis. The belief has become a central theme in discussions in Congress and the Executive Branch on immigration bills (and attending policies on bringing in high-skill guest workers), on education and the causes of economic stagnation domestically, and on the nation's competitive position globally. This enduring perception of a crisis of supply might logically lead to some obvious questions. Why is the market not producing graduates in science, technology, engineering, and mathematics—the STEM fields—who would be sufficient in quantity and quality to meet demand? Why does this particular labor market fail to operate as it should?

But there are better questions to ask. Why is the widely accepted view of shortage at odds with study after study that has found the U.S. science and engineering supply to be strong and improving? And why are policymakers and industry leaders offering proposals that go against this solid body of evidence?

STEM market and the economy

Before offering a more detailed analysis, it is worthwhile to examine two widely cited claims about shortages: the headline-grabbing statement by the former head of Apple, Steve Jobs, to President Barack Obama about an engineering shortage, and the recent claim by the president's Jobs and Competitiveness Council that the economy needs to produce an additional 10,000 engineers each year to address a shortage and thereby spur innovation to jump-start the lackluster jobs market and economy.

At a meeting in February 2011, Jobs told the president that Apple would have located 700,000 manufacturing jobs in the United States instead of China if only the company had been able to find enough U.S. engineers to support its operations. Apart from there being no indication that Apple actually tried to search for engineers, or that it actually has a problem attracting engineers, some simple math suggests that the plausibility of this claim should be reconsidered.

If Apple located its manufacturing in the United States and paid the national average for electronics production worker wages, it would cost the company about \$42,000 per worker per year. In China, Apple's contract manufacturer, Foxconn, pays workers \$4,800 per year. Thus, manufacturing in the United States would cost Apple an additional \$26 billion each and every year, an amount that is slightly more than the company's reported net profit for 2011. Even if the company was willing to sacrifice its entire profit for an act of patriotism, would it have been hamstrung by an engineering shortage? Apple surely could have outbid other companies for the 8,700 industrial engineers it said it needed, or it likely could have just matched wages and attracted them because of its reputation and perceived "cool" factor. It does not appear, then, that it was an engineering shortage that led to Apple's offshoring decision.

The suggestion by the president's Jobs and Competitiveness Council that the nation's economy is hampered by a shortage of engineering graduates also earns doubt. To evaluate this claim, it is only necessary to turn to another of the president's councils, the Council of Advisors on Science and Technology. According to its analysis of the engineering workforce, the nation is currently graduating about 25,000 more engineers every year than find work in that field. More-

over, it seems that some companies suffer from a surfeit of technology workers. In September 2012, Hewlett Packard announced that it planned to lay off 15,000 workers by the year's end, reaching a total of 120,000 layoffs over the past decade. Or consider General Electric's recent relocation of its 115-year-old X-ray headquarters from Wisconsin to Beijing, after earlier expansion of its corporate R&D labs in India and China. These companies represent the general trend, in industry after industry, of locating STEM-intensive activities offshore while shrinking their U.S. workforces. IBM, for example has reduced its U.S. workforce by 30% and now has four times more offshore than domestic employees. It is thus a rather curious proposition that companies are seeking more STEM employees at the same time that they are laying off huge numbers of STEM workers and increasing the employment of offshore STEM workers who earn a fraction of U.S. salaries. It is not clear what producing another 10,000 engineers would do, especially as fewer engineering graduates find engineering jobs and salaries are flattening for all but a few fields.

These examples illustrate the quandary of trying to understand the STEM shortage debates. On one hand, the claims of shortages and of an apparent failure of the market to produce enough workers do not appear to be supported by the available evidence. On the other hand, authoritative voices on shortages and the constant repetition of the claims are proving compelling enough for policymakers. Assessing the supply of—and demand for—STEM workers requires a broader look at the context and evidence.

Brief history of skill shortages

At the turn of the 20th century, U.S. industrialists were faced with skill shortages. The robber barons, facing a paucity of tile makers and other highly skilled craftsmen, had to bring in European tradesmen as guest workers to construct their mansions. Henry Ford also faced a skills shortage when developing plans to produce automobiles in Michigan. Automobile production at the time depended on highly skilled craftsmen, bicycle builders for the most part, to build hand-crafted and expensive vehicles. Unable to find skilled workers in the nation's interior or to attract them to the region, Ford considered how he could build a high-technology product with workers drawn from the farms, lacking craft or industrial skills. His solution—the production line—changed the face of production the world over, although its success also required national networks of technology support services provided by shade-tree mechanics who learned auto repair by tinkering with engines in their yards at home.

At the turn of the current century, high-technology indus-

tries were facing many of the same dilemmas and choices of the past: how to develop a skilled workforce, and how to have highly engineered products produced and supported more widely and at lower cost. For its part, the IT industry was composed of several different segments: a product market that depended on a high-skill craft production model and a large services market that was a mix of legions of programmers performing routine development and higher-skilled analysts and custom systems and services developers. During the 1990s, demand increased across the IT industry, as new products were developed, PCs proliferated, and inexperienced users needed ever greater levels of support.

Toward the end of the 1990s, the demand for programmers was exacerbated by the Y2K crisis, which necessitated the modification of existing software systems or the transition to new enterprise-wide software packages (or both) that required extensive customization, debugging, implementation, and support across entire organizations. Along with these challenges, the industry faced steeply increasing salaries, further exacerbated by the emergence of the dot-com bubble, which had distorted this labor market by the lure of turning its workforce into nearly instant millionaires and creating a surge in labor demand that was not sustainable over the longer term. Genuine panic spread beyond the IT industry as forecasters, caught up in the enthusiasm of the “new economy,” predicted vast expansion of the IT industry and growth of an “information economy” that would require knowledge workers in numbers exceeding the size of the rest of the economy.

The industry responded to the challenges in similar fashion as its forbears: It trained legions of capable, if unskilled, workers in the interior (but of India, not the United States) and imported guest workers, often by routing them through colleges that could give them the industry-relevant skills to be employable. This shift in IT resulted in moving the more routine and lower-skilled work offshore and using lower-cost offshore firms to do the service work onshore.

There was widespread political reaction. In the course of a single year, 2004, the legislatures in 40 states introduced a

total of more than 200 bills restricting offshoring (as compared with legislation proposed in only 4 states the year before). And the presidential candidate John Kerry, in a speech to his supporters, denounced offshoring firms and promised to eliminate tax loopholes for any “Benedict Arnold company or C.E.O. who take the jobs and money overseas and sticks you with the bill.”

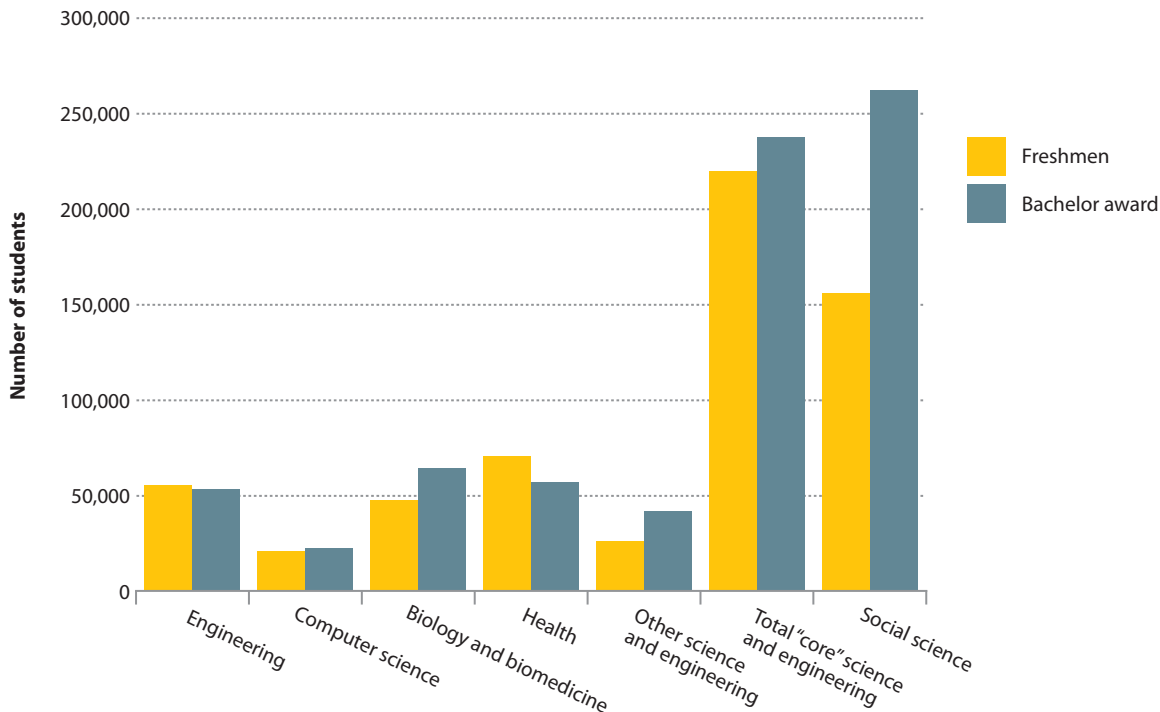
It is in this context that it is possible to understand the genesis of the talent shortage claims. Initially, firms were focused on cost as the justification for moving operations offshore, and Wall Street analysts reacted favorably to every offshoring announcement. But in the face of growing public opposition to offshoring operations and layoffs, government and industry messaging about offshoring shifted from cost savings to the need for a talent search to compensate for a lack of sufficient supply of trained workers in the United States. Notably, the National Research Council in 2005 issued a report called *Rising Above the Gathering Storm*, which identified a need for the country to invest more in research and innovation and to train more people to do the work. And five years later, a follow-up report by committee chair Norm Augustine likened a perceived deepening of these problems to a Category 5 storm capable of wreaking untold destruction on the nation’s economy. The conclusions dominated the public narrative and continue to do so to this day, giving support to a peculiar claim that workforce shortages can best be met—and perhaps only be met—by increasing the inflow of high-skill guest workers.

Truth in the evidence

But researchers have time and again examined such claims and failed to find much evidence to support them. Examples of such reports include *Into the Eye of the Storm: Assessing the Evidence on Science and Engineering Education, Quality, and Workforce Demand*, published by the Urban Institute in 2007, and *Will the Scientific and Technology Workforce Meet the Requirements of the Federal Government?* by RAND in 2004. Studies that Lindsay Lowell and I have conducted also have found not only significant progress in STEM education

FIGURE 1

Number of science and engineering freshmen and graduates in 2003 college cohort (graduating within six years)



SOURCE: U.S. Department of Education, National Center for Education Statistics, 2003/04 Beginning Postsecondary Students Longitudinal Studies, Second Follow-ups (BPS:04/09); tabulations by authors)

and workforce development, but an ample supply of top-performing STEM graduates for what is, in fact, the small segment of industries in the economy (employing about 4 to 5% of the entire workforce) that depend on STEM workers.

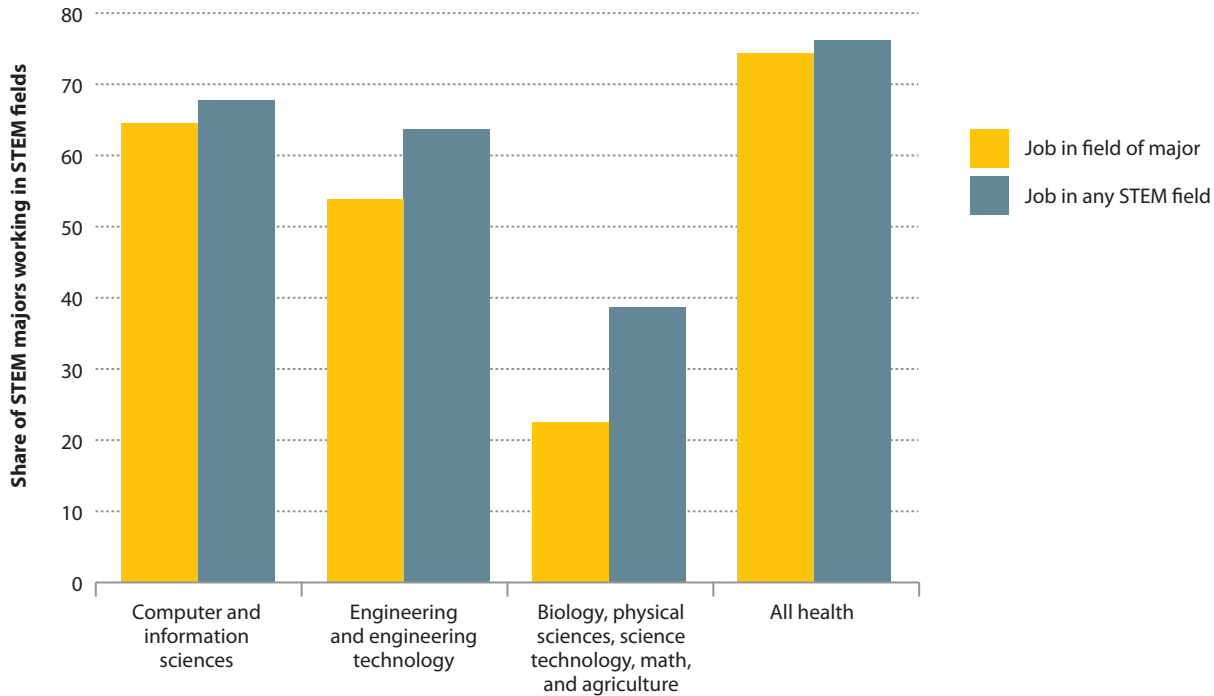
Reviewing the empirical research in context, focusing on three key areas, may be useful for arriving at the facts needed to truly inform policy decisions about STEM-related issues.

The first area to consider is the broad notion of a supply crisis in which the United States does not produce enough STEM graduates to meet industry demand. In fact, the nation graduates more than two times as many STEM students each year as find jobs in STEM fields. For the 180,000 or so openings annually, U.S. colleges and universities supply 500,000 graduates. Accepting that STEM field definitions are overly restrictive and that in even marginally related occupations there could be a productive use of workers with STEM degrees, these numbers still represent a 50 to 70% greater supply than demand. Engineering has the highest rate at which graduates move into STEM occupations, but

even here the supply is over 50% higher than the demand. IT, the industry most vocal about its inability to find enough workers, hires only two-thirds of each year's graduating class of bachelor's degree computer scientists. By comparison, three-quarters or more of graduates in health fields are hired into related occupations (see Figure 1).

But proponents of supply crisis claims push even further, arguing that STEM is a "leaking pipeline," with students fleeing science and engineering fields in college because the courses are too difficult, the students are not prepared, or the students lose interest because society somehow has not provided them the motivation of a compelling national interest similar to the Cold War, with leaders now proclaiming a need for a new "Sputnik moment."

Although the argument may sound plausible, the evidence once again is not quite aligned. Today's students are taking more science and math courses (and performing better in them) than in any past generation. The extensive STEM enhancement programs funded by the National Sci-

FIGURE 2**Occupational field of STEM college majors one year after graduation, 2009**

Source: National Center for Education Statistics. (2013). 2003–2004 Baccalaureate and Beyond Survey (B&B) [Restricted data file]. Washington, DC: U.S. Department of Education.; tabulations by authors.

ence Foundation and other government and nongovernmental foundations and organizations appear to have raised the general level of STEM education across a wide range of disciplines (for example, half of all college STEM credit hours are taken by non-STEM majors) and significantly increased STEM studies among underrepresented minorities and women.

Remarkably, the number of STEM majors, from first year through graduation, expands rather than shrinks. And among students who graduate within six years of enrollment, the number who start with a non-STEM major but graduate with a STEM degree is greater than the number who start in a STEM major and graduate with a non-STEM degree (see Figure 2). Even in the demanding field of engineering at a top school such as Stanford University, one of every nine graduates did not start as an engineering major but transferred into the program after the first year. So, yes, some students enter college thinking they want to be a scientist or engineer and then move to another major for one

reason or another, but it seems that a greater number of other students find at some point in their studies that a STEM degree is more attractive.

Indeed, this loose coupling of students' initial disciplinary choices and ultimate career paths might be expected, because college is often a period of exploration. The U.S. education and employment system is not designed to be tightly coupled as in other countries such as Germany, with its highly proscribed education and career tracks (beginning at age 14 and involving a national curriculum of sequenced courses and skill development for most jobs, and credentialing of jobs throughout the skill spectrum). Instead, the United States has a fluid system in which career paths can be pursued through a range of disciplines and educational experiences. Among students entering college undecided or unknowledgeable about future careers, it seems that the attraction of STEM is more compelling than popularly claimed. Importantly, this may well be a strength of the U.S. system: It allows those who are not passionate about

The nation graduates more than two times as many STEM students each year as find jobs in STEM fields.

the field to exit early and those who take longer to find their calling the ability to pursue it, and to bring with them a broader educational background.

Failing to find current shortages, the argument then is turned to the qualifications of “STEM-eligible” students, and specifically to the idea that U.S. students, on average, do not perform well on international tests. But evidence for this claim fails for a number of reasons. First, average scores of the students tested (mostly middle-schoolers) do not indicate the performance of the actual population that finds its way into STEM occupations. Of the students tested, about 25% will graduate with a four-year college degree; of those students, about 17% will graduate in a STEM field; and of those students, about half will enter a STEM or STEM-related field. This suggests that the performance of one very small segment—2 to 4%—of the overall student population is actually sufficient for evaluating the supply potential for the STEM labor force.

Second, the performance of the upper portion of the U.S. student distribution is world-class, and this segment is larger than most of the relevant populations in the oft-touted high-performing countries, such as Singapore, South Korea, Finland, or any of the central or eastern European countries formerly part of the Soviet Union.

Third, the average test scores of the countries that are of most concern as economic competitors would be dismal if a more representative sample of their students were tested, as is the case in the United States. China and India, in particular, have very large illiterate populations that would lead to devastatingly low averages.

Fourth, and of special interest, there is no credible evidence that scores on these tests have any relevance for the outcomes of interest: science and engineering performance, innovation, and economic competitiveness. A quick scan of the top-performing countries on education tests makes this apparent, because the list contains Slovenia, Estonia, the Czech Republic, and many other former Soviet countries, but not Brazil, Chile, or Israel. Moreover, the rotating list of top performers over the past decade does not appear

to correspond to the rotating list of economic or innovation top-performing countries.

Perhaps even more telling, despite decades of supposedly low performance by U.S. students, the world has seen no credible competitors to the nation’s innovation regions (Silicon Valley in California, Route 128/Kendall Square in Massachusetts, Research Triangle Park in North Carolina, the biopharma corridor of New York and New Jersey). No doubt there will be innovation hubs emerging in other parts of the world in the near future. But that will not be prevented by improving the average scores of U.S. students, nor is there a reason why the United States should try to prevent the rise of other global innovation hubs or the overall improvement of other national economies. As my colleague Leonard Lynn and I have argued, we need a new global innovation strategy to achieve collaborative advantage with rising technology powers.

The second area to consider is the argument that even if STEM graduates are not employed in a STEM job, there are individual and social benefits to obtaining a STEM degree. But again, the evidence is thin, at best. Analyses typically compare STEM graduate salaries with those of all graduates, or STEM occupations with all occupations. An analysis conducted by my colleague Lindsay Lowell examined the average incomes among two sets of students: one group who started college interested in STEM, got a STEM degree, and entered a STEM field; and another group that started with similar interests but then chose another, non-STEM occupation. He found that the students not entering a STEM occupation went into fields that paid more than STEM occupations. A STEM career, then, does not seem to offer pay advantages for high-performing students.

Even for STEM graduates who do not go into STEM fields, it is claimed that they will still do better economically than non-STEM graduates. There is some truth to that, but it is not the entire story. STEM graduates make up about 17% of four-year undergraduates and about 5 to 7% of the overall workforce. It is a reasonable premise that the selectivity of STEM fields will result in a group of students with above-average academic performance. It may be that STEM

graduates are, on average, higher-performing and go into higher-paying fields than those chosen by other students.

My colleague Leonard Lynn and I have additional evidence from interviews and some quantitative evidence about the purported advantages of STEM training and jobs. Our interviews with engineers, technology managers, and others in STEM fields find a broad and deep consensus that these fields are not highly attractive as careers financially or for employment stability. In the IT industry, a common view among managers and workers is that the occupation was great for their generation but the ride is now over, and they would not recommend an IT or engineering career to their sons and daughters. The threat of offshoring and an influx of guest workers are paramount in their assessment of the prospects in these fields. In life sciences, the perception is much the same, as most Ph.D. graduates will be likely to hold one or two postdoctoral positions, earning \$50,000 a year for half a decade or more, and then be thrown into a poor job market in their mid-30s. These might be careers worth pursuing if one loves the work and is willing to play the job lottery, but they are not occupations attractive to those for whom the pay and conditions (relative to their other options) weigh strongly in the decision.

It may not be surprising, then, that some STEM students are showing a decline in persistence to stay in the field. Among recent cohorts we have studied, there has been a significant and dramatic decline in top-performing STEM students who make the transition to STEM occupations. This is in contrast to medical fields, which maintain their allure for the best and brightest, are still highly competitive, and have not significantly increased the number of degrees awarded for the past several decades. Although there may be a social cost in restricting the supply of workers, this must be evaluated in the context of the benefits of a market that continues to attract highly qualified students. In other words, in the market for STEM graduates, there is a price/quality tradeoff.

So if you are a STEM-capable student, what type of education will provide you with the best occupational options? Remarkably, there is no in-depth research addressing this

question. My colleagues and I will be conducting that analysis in an upcoming project and can then provide a much more accurate assessment of the actual value-added of a STEM education (versus selection bias). But the current bottom line is that there is little compelling evidence to support efforts to herd into STEM majors any students who do not have an abiding interest in a STEM career.

The third area to consider is whether the customary market forces are, as claimed, not having their usual effect on supply and demand in STEM fields. This may be the most important claim, but what is the evidence that labor markets are not responsive? Would it not be logical to expect a rather high bar of evidence of market failure before advocating government intervention to distort the market-responsive level of supply? Here again, there is substantial evidence that the STEM labor market appears to work reasonably well. In the IT industry, from the 1990s through the peak of the dot-com bubble, wages climbed steeply. So, too, did the number of computer science graduates. After the bubble burst, wages fell, followed by a decline in the number of computer science graduates. Since then, wages have stayed well below their earlier peak and now hover around wage levels of the late 1990s.

If there were a talent shortage, where are the market indicators (namely wage increases) that signal students there is an opportunity to pursue a career in this industry that is better than their alternatives? Or has government policy restructured this labor market to supply seemingly endless numbers of guest workers who, coming from low-wage countries and constrained in their employment options, will understandably flock to these jobs even if wages are stagnant? With current policies that provide guest workers in numbers equal to as much two-thirds of new jobs in IT, it becomes less important for the IT industry to use the domestic market to supply its workforce. The petroleum industry also claims to be experiencing a sharp rise in its demand for petroleum engineers as new exploration increases and its current workforce starts to retire. But unlike the IT industry, petroleum companies stepped up the wages offered to

Guest workers provide benefits to the companies that hire them in the form of lower wages, but there is little evidence to suggest that they strengthen the nation's science, engineering, or technology workforces.

new graduates by 40% over five years. As a result, the number of graduates more than doubled. These natural experiments provide strong evidence that STEM labor markets are responsive to market signals.

Immigration versus guest workers

A final claim is that the success of the United States as an immigrant nation speaks to the benefits of an expansive guest worker program. It is this argument that presents the greatest confusion and conflicting claims that are genuinely difficult to disentangle. Distinguishing between labor policy and immigration policy is key to analyzing why the history of benefits from immigration is unlikely to occur from the new guest worker policies in some of the legislation now being developed.

Immigration policy addresses broad issues of diversity, equity, opportunity, and the long-term vibrancy of the United States. Historically, the nation's essential experience (for other than Native Americans) is the immigrant story in nearly everyone's family history, intertwined with the country's success as the beneficiary of talented immigrants fleeing social, economic, and political unrest in their home countries and seeking the opportunities particular to U.S. society. Immigration from high-skill diasporas has varied from accomplished Soviet émigrés fleeing a crumbling régime to Nazi scientists who were extracted from Germany as part of Operation Paperclip to advance strategic and military advantage in the Cold War. Research on immigration identifies a range of positive (and some negative) impacts, and the numerous examples of immigrant-founded companies and illustrious achievements of immigrants across different areas, from the arts to the sciences to business, testify to the benefits of a society that welcomes them.

In contrast, many policymakers are promoting much narrower policies to promote an inflow of high-skill guest workers, even proposing such actions as awarding automatic green cards to any foreign STEM graduate of a U.S. university. But guest workers targeted to a specific industry sector and filling the vast majority of openings, unlike their immigrant

counterparts, are likely to have a significantly negative impact on STEM (and particularly IT) labor markets, occupations, and careers. Thus, guest worker policy is vastly different from broader immigration policy, and the contributions of immigrants are also different from the impact of a large flow of high-skill guest workers targeted to one or several industries, particularly in the absence of compelling evidence of shortages. It is, in fact, the important role of immigration to the nation—socially and economically—that may be undermined by high-skill guest worker programs.

In terms of labor market impact, particularly in high-technology industries, a further distinction arises from the difference between the permanent domestic labor force (native and immigrant, citizen and permanent resident alike) and the temporary guest worker labor force. The various cases of notable immigrants typically involve those who came to become permanent members of the nation, and they generally migrated as children and grew up as part of U.S. society. People who immigrate to the United States become part of the domestic workforce, whereas guest workers are brought in for a specific sector of the labor market.

Another important distinction is the difference between the “push” and “pull” drivers of immigration. Most of the broad waves of immigration, particularly high-skill immigration, have been push-driven, with people leaving their home country because of inhospitable conditions. In contrast, guest workers are recruited, or pulled, in large numbers, often for a particular industry. They will have a different impact on the labor force, and the effects may not be as nationally advantageous as widely proclaimed.

The actual use of guest workers makes this clear. For example, the guest worker programs are being driven primarily by a small industry segment that is targeting largely entry-level workers; two-thirds of current entering IT guest workers are under the age of 30 (see Figure 3). Moreover, Ron Hira, an engineer and policy analyst who focuses on these issues, has found that the companies that bring in over half of all H-1B visa holders appear to have no need for them in their permanent U.S. workforce and do not sponsor them

Broad, diverse immigration policies can strengthen the nation, whereas targeted, restrictive guest worker policies are more likely to undermine it.

for permanent residency. Norman Matloff, a professor of computer science who follows immigration and high-tech workforce interactions, has observed that guest workers have lower rates of innovation than their U.S. counterparts.

In addition, in earlier research my colleague Radha Biswas and I found that a large portion of IT guest workers are the necessary conduit for offshoring IT work, because an offshore project requires about a third of the team to be onshore to work with the client, do requirements analysis, and liaise with the offshore team. One might argue that offshoring provides some benefit to the U.S. economy (for example, by lowering wages and thus reducing product prices), but it does not expand or strengthen the domestic STEM workforce. In fact, it has quite the opposite effect. The only clear impact of the large IT guest worker inflows over this decade can be seen in salary levels, which have remained at their late-1990s level and which dampen incentives for domestic students to pursue STEM careers (and, ultimately, for truly talented global students to come to the United States). Guest workers provide benefits to the companies that hire them in the form of lower wages, but there is little evidence to suggest that they strengthen the nation's science, engineering, or technology workforces. Moreover, it is underrepresented minorities and recent permanent immigrants who are most likely to be disadvantaged through lower-paying jobs and job loss due to newly arriving guest workers.

Basing policy on evidence

It seems clear, then, that broad, diverse immigration policies can strengthen the nation, while targeted, restrictive guest worker policies are more likely to undermine it. It also seems clear that because evidence supposedly informs policy, the past failures of shortage predictions should serve as further caution to policymakers who may overlook the costs of ill-founded conclusions. For all the unknowns and uncertainties of labor market projections and supply/demand analyses, there is still a substantial and solid body of research and experience that should caution policymakers about being swayed by conventional wisdom offered by prominent ad-

vocates for a particular policy that may have limited or short-term benefit and that can have deeply negative and long-lasting impacts.

Finally, policymakers and industry leaders may want to reconsider the notion that science and engineering development and national competitiveness are best served by such a concentrated focus on one or just a few disciplines or workforces. Rather, it may be the range of disciplines and talents that provides the United States some of its dynamism, innovativeness, and creativity. William J. Baumol, an economist who has written extensively on labor markets and technology, has argued (especially in a notable article published by the National Bureau of Economic Research in 2004) that entrepreneurs, who are disproportionately responsible for major innovations over the past century, are innovative because they have not gone through formal science and engineering education. In his view, this is because "education for mastery of scientific knowledge and methods... can impede heterodox thinking and imagination," and because "large-firm R&D requires personnel who are highly educated in extant information and analytic methods, while successful independent entrepreneurs and inventors often lack such preparation."

In the same vein, Steve Jobs has famously said that Apple, which is among the world's most highly valued companies, represents the intersection between technology and the humanities. And before him, Edwin Land, a pioneering figure behind Polaroid and a developer of the nation's first advanced aerial imaging technology, as well as a key adviser in founding NASA, pointed to the importance of "standing at the intersection of humanities and science."

The achievements by these and other truly innovative individuals who often reached success through different and unexpected routes should be seen as the strength of the fluidity of the U.S. education and career system. They should also be seen as coming from a broadly focused immigration policy and investment in the domestic workforce, rather than from finding narrow substitutions for the domestic workforce.

Recommended reading

- Ron Hira, "U.S. Workers in a Global Job Market," *Issues in Science and Technology*, Spring 2009; <http://www.issues.org/25.3/hira.html>.
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- Leonard Lynn, Harold Salzman, and Daniel Kuehn *Dynamics of Engineering Labor Markets: Petroleum Engineering and Responsive Supply*, paper presented at U.S. Engineering In The Global Economy, September 26 to 27, 2011 (National Bureau of Economic Research, Cambridge, MA, 2011); http://conference.nber.org/confer/2011/SEWPf11/Lynn_Salzman.pdf.
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