

**Conference Report**  
**Dynamics of the STEM Labor Market**  
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Report of the July 11, 2011 Workshop  
July 20, 2011

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**Summary**

The July 11, 2011 workshop at Georgetown reviewed projections of the demand for and supply of S&E workers, regulations governing the admission of foreign S&E students and workers, and hiring patterns in STEM labor markets. The major themes of the workshop included:

1. Connections between STEM graduates and STEM employment. There are about three times more Americans with degrees in STEM or S&E fields than are employed in S&E occupations. There is agreement that many of those earning S&E degrees are “diverted” to non-S&E occupations, and that many of those earning advanced degrees in life sciences have lower lifetime earnings because of lengthy low-paid post-docs, but there is disagreement over what diversion from S&E and reduced lifetime earnings mean for education, immigration, and other policies.

Those seeking to maximize S&E brains within US borders urge more support for S&E training and easy admission and stay for foreign S&E graduates and workers under the theory that more S&E-trained individuals in the US will maximize innovation and economic growth. Those seeking to improve the earnings and attractiveness of S&E occupations to Americans question federal research policies that encourage the employment of post-docs and immigration policies that easily admit foreigners who seek US educations, jobs and immigrant visas.

2. The major S&E guest worker program is the H-1B program, created in 1990 to give US employers easy access to foreigners with at least a bachelor’s degree coming to the US to fill jobs that normally require a bachelor’s degree. Proponents expected that the number of visas issued might double from less than 20,000 in the late 1980s to 40,000 or more until US students and universities caught up with rising demand for S&E workers, so the annual cap was set at 65,000. However, H-2B admissions rose slowly in the early 1990s and continued to increase.

Presentations emphasized that most H-1B visa holders arrive in the US as F-1 students. After graduation, many S&E majors stay up to 29 months of Optional Practical Training, work with H-1B visas for six years, and are sponsored by their US employers for immigrant visas. There was general agreement that this Darwinian system that ultimately puts most of the initial power to admit foreigners into the hands of universities is less-than-ideal, but little consensus on how to begin to revise it. Major recent changes include lengthening OPT for S&E graduates and highlighting the inability of the H-1B program to protect US workers.

3. Individual factors and federal research and immigration policies influence the supply and demand for S&E workers, but there is disagreement on whether federal policies strengthen or weaken the US economy in the long term. There is agreement that H-1B visa holders are generally younger than US workers in the same occupation, raising questions about whether employers prefer young H-1B graduates to older US workers because they have “fresh” skills or because they are cheaper. An analysis of enrollments and salaries for petroleum engineers suggests that markets work. When salaries for petroleum engineers surged, so did enrollments of US students.

Simple solutions to complex immigration and S&E labor market issues often create new and unexpected problems. There are trade offs between competing goods when admitting immigrants, and it is difficult to engage in honest discussions of the short- and long-run consequences of such trade offs when the debate is dominated by those with direct economic interests in particular policies. Finally, it is hard for policy makers to foresee unintended consequences of policy decisions, and hard to change migration policies after economic interests that depend on the status quo evolve.

### **Projections**

The US Bureau of Labor Statistics (<http://bls.gov/>) projects the number of jobs and workers for the coming decade in odd-numbered years, that is, the 2008-18 projections were released in November 2009. The methodology for making job and worker projections begins with forecasts of the US economy. BLS assumed that real or inflation-adjusted US Gross Domestic Product (GDP) would grow by 2.4 percent a year between 2008 and 2018, that productivity would rise 1.8 percent a year, and that the labor force would expand by 0.8 percent a year. Using these assumptions, US GDP is projected to increase from \$11.7 trillion in 2008 to \$14.7 trillion in 2018 (year 2000 dollars).<sup>1</sup>

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<sup>1</sup>BLS relied on a private firm, Macroeconomic Advisors, to project the US economy. There are several key assumptions that affect the size of the economy in 2018, including that the interest rate on 10-year treasury notes will be 4.5 percent in 2018, the federal deficit will be \$900 billion in 2018, and the US population will be 335 million in 2018, generating a labor force of 167 million.

The BLS then estimates the number of jobs needed to produce this projected economic output. It projected that the number of jobs would increase from 151 million in 2008 to 166 million in 2018, up 15 million. Some 116 million or 77 percent of these jobs in 2008 are expected to be in services, and almost all of the job growth projected between 2008 and 2018 is in services.<sup>2</sup>

BLS also projects the labor supply, which has four major dimensions: people, participation, hours, and skills. BLS focuses on the first two dimensions, the number of people 16 and older and the share in the labor force, that is, the number employed or looking for work. BLS projects declining labor force participation, only 64 percent in 2018, down from 66 percent in 2008 (each 1 percent decline in the share of persons 15 and older in the labor force represents about 2.5 million people).

The major US labor force trends include slower growth, a higher share of older workers, and a higher share of Asian and Hispanic workers. The labor force is projected to increase by almost 13 million between 2008 and 2018, down from increases of over 16 million in each of the previous decades. The share of workers under 25 is expected to fall, while the share 25 to 54 and 55 and older is projected to rise. By 2018, the US labor force is projected to be 64 percent non-Hispanic whites, 18 percent Hispanics, 12 percent Blacks, and six percent Asian and other.

Some believe that BLS underestimates the employment of college-educated workers and that the US faces a chronic shortage of STEM talent. He expects the number of jobs in STEM occupations to increase from 6.8 million to eight million between 2008 and 2018. In 2018, alternative projections expect 43 percent of STEM jobs to be filled by persons with BS degrees, 24 percent by persons with graduate degrees, and 13 percent by persons with associate degrees (the remaining 19 percent are expected to have high-school diplomas and some college); that is, a third of STEM jobs in 2018 are expected to be filled by persons without at least a college degree.

Detailed study of the requirements of jobs via O\*Net ([www.onetonline.org](http://www.onetonline.org)) leads some to believe that the interests and values that push people into STEM education and occupations are “hard-wired” early in life, making it difficult to encourage more Americans to get into STEM. Furthermore, because of the “diversion” of STEM graduates into non-STEM careers, the US may need five high-school students with top-quartile math scores to produce one US STEM worker. This diversion of STEM graduates into non-STEM occupations a problem may not be rectified easily, since the health-related and managerial occupations that attract some STEM graduates offer higher and faster rising salaries, and STEM degree holders in health-related and managerial occupations

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<sup>2</sup> Goods-producing industries including construction, mining, and manufacturing employed 21.4 million in 2008 and are projected to have the same number of jobs in 2018. Agriculture employed 2.1 million in 2008 and is projected to have two million jobs in 2018.

earn more than non-STEM degree holders in these fields.<sup>3</sup> However, because of diversion, some argue that the US should encourage more Americans to earn STEM degrees and permit foreigners to study and work in STEM fields.

Others examined employment projections in biomedical occupations. The National Research Council projects the number of research scientists in biomedical fields a decade ahead, and in 1994 added a multi-state life table approach to estimates derived from the Survey of Earned Doctorates (SED) and the Survey of Doctorate Recipients (SDR). In 2001, there were 113,000 US-trained PhDs with biomedical degrees, including 100,000 who were employed, and 25,000 foreign-trained biomedical PhDs.

The issue is whether there are enough biomedical PhDs to fill market needs. In the mid-1990s, the median time as a post-doc among recent biomedical PhDs was 46 months, that is, almost four years. The federal government doubled funding for NIH, which supports biomedical research and the training of biomedical PhDs, to enable younger researchers to obtain “real” jobs sooner after graduation and become PIs on federal research grants. However, the increase in NIH funding instead led to larger research grants to senior researchers rather than the funding of new scholars as PIs, and the need for post doc and PhD students to staff these projects persisted.

The federal government shapes the supply and demand for biomedical PhDs. Federal policies that aimed to shorten time as post docs and help young researchers become PIs failed to achieve their goals. One response is the creation of professional science masters (PSM) degrees that add the management training desired by industry rather than PhDs seeking limited government research funding.

The consensus of the discussion is that it is far easier to project the supply of workers with the training to fill STEM jobs than demand, that US students do respond to market signals, such as avoiding petroleum engineering during the bust of the 1980s and boosting enrollments in the 1990s with rising prices and exploration, and that PSM degrees may gain favor in both industry and universities over time.

### **Regulating Admissions**

The US H-1B program admits up to 65,000 foreigners a year who have at least one university degree and are requested by US employers, another 20,000 with advanced degrees from US universities, and an unlimited number hired by US universities and non-profit employers. During most of the past two decades, employers requested more than 65,000 H-1B visas, and they persuaded Congress to raise the cap between 1999 and 2003.

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<sup>3</sup>Real wage growth in engineering occupations was only about 17 percent between 1980 and 2010, and wage increases in other STEM occupations were less than 35 percent, versus about 53 percent wage increases in health-related and managerial occupations. Note that wage growth in non-STEM occupations was about 23 percent, more than for engineers, but less than life sciences and computer-related occupations.

The question of whether the H-1B cap should be raised, and whether employers should be required to recruit US workers before employing H-1B workers, has dominated discussions of foreign students and workers in STEM occupations for the past decade. Many assert that foreign STEM students and workers are among the “best and brightest” and lament the fact that, in years when more than 65,000 H-1B visas are requested by employers, some foreign graduates of US universities cannot stay and work in the US. President Obama in his January 25, 2011 State of the Union speech said: “let's stop expelling talented, responsible young people who could be staffing our research labs or starting a new business, who could be further enriching this nation. It doesn't make sense to grant these students graduate degrees and then send them back home to compete with us.”

Recent regulatory changes to the Optional Practical Training program extend the time in the US of foreign graduates of US universities. All can stay in the US 12 months after graduation and engage in paid OPT if recommended by their school's Designated School Official and approved by USCIS. Beginning in April 2008, foreign graduates of US universities with STEM degrees can stay a further 17 months (for a total of 29 months) if their US employers are enrolled in E-Verify. Some 16,600 foreign STEM graduates have had extended OPT approved in the past three years, just over 5,000 a year; about two-thirds are Indians.

DHS defined STEM in its April 8, 2008 regulations to include engineering, math and statistics, and computer-related fields ([www.ice.gov/sevis](http://www.ice.gov/sevis)); SEVIS accepts recommendations to add to the list of STEM occupations. Several participants noted that, in the absence of an “official” definition of STEM occupations, the DHS list for OPT could become the US government definition of STEM. Anecdotal evidence suggests that some foreign students may be changing their majors to DHS-defined STEM fields to give them 29 rather than 12 months of OPT.

A January 14, 2011 GAO study examined the impacts of the 65,000 a year cap on H-1B visas on the US firms and workers ([www.gao.gov/products/GAO-11-26](http://www.gao.gov/products/GAO-11-26)). GAO examined employer requests for H-1B visas, how the 65,000-a-year cap affects US firms, H-1B characteristics, and protections for US workers. In most years, employers request more than the maximum number of H-1B visas available.<sup>4</sup> H-1B visas are concentrated by occupation and employer. Between FY00 and FY09, less than one percent of employer applicants received approval for 30 percent of H-1B visas. Many of these top requesters of H-1B visas were “staffing companies” that place workers with a series of employers.

GAO found it hard to evaluate the impacts of the 65,000-a-year cap on US employers. Large employers that did not get H-1B visas for the foreigners they requested were usually able to hire them in other (unspecified) ways; smaller

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<sup>4</sup> Universities and nonprofits are exempt from the cap on H-1B visas. Between FY00 and FY09, about 14 percent of requests for H-1B visas came from cap-exempt employers; in FY09, about 87,500 new requests and extensions of H-1B visas were approved for 6,000 quota-exempt employers.

firms switched to other (presumably US) workers. There were complaints that the H-1B lottery process used by DHS when requests exceed 65,000 does not allow employers to prioritize their H-1B applications, and that the H-1B application process forces bunched hiring.

Almost half of the recipients of H-1B visas between FY00 and FY09 were Indian, followed by almost 10 percent Chinese; other nationalities were each less than five percent of recipients. At least 18 percent of those approved for H-1B visas between FY04 and FY07 had applied for immigrant visas by 2010 (foreigners with H-1B visas can remain in the US indefinitely while their applications for immigrant visas are pending).

H-1B visa holders earned less than US workers in the same occupation, but they were also younger. Younger H-1B and US workers had similar earnings, but older H-1B workers earned less than US workers of similar age in computer-related jobs, but not in university jobs. GAO noted that many post-docs hold H-1B visas that are exempt from the cap, and that the availability of foreign H-1B post-docs may discourage US students from earning biomedical degrees because of typically lengthy post-docs at relatively low wages.

The US has 70 nonimmigrant or temporary visitor visas, and the H-1B visa is one of the 24 major categories. Most temporary visitors leave within a month, but there were an estimated 1.8 million foreigners holding temporary visitor visas in the US in 2008; half who were workers and their families and a third who were students and their families.

Many H-1B visa holders are foreign student graduates of US universities, meaning they arrived in the US with F-1 visas, graduated, and engaged in 12 or 29 months of OPT if they were not hired with an H-1B visa upon graduation. The H-1B program, unlike the H-2A (farm) and H-2B (nonfarm) guest worker programs, does not require most US employers to try to recruit US workers before hiring H-1Bs, does not require payment of comparable benefits to H-1B visa holders, and does not provide layoff protection for US workers, that is, most US employers can lawfully lay off US workers and replace them with H-1B visa holders.

Foreigners with H-1B visas may become immigrants, and many do. Many US employers sponsor their foreign H-1B visa holders for the 40,000 third-preference employment visas available each year to skilled and unskilled foreigners. However, since H-1B admissions are higher than the number of third-preference visas available, there are backlogs, waits, and uncertainties that lead to frustration for foreigners seeking immigrant visas. Almost all foreigners seeking employment-related visas are in the US when they are "admitted" or issued immigrant visas.

### **Impacts**

During recession, private firm R&D spending and S& E employment could fall because firm earnings decline or rise because R&D becomes relatively cheaper.

Both R&D spending and S& E employment are pro-cyclical, meaning they rise during economic expansions and fall in recession, but S& E employment is less sensitive to recession than S&E expenditures, suggesting that firms “hoard” or retain S&E workers during recessions because of the difficulty of hiring and training them.

IT employers may hire foreigners with H-1B visas to save money. In IT-related industries, employers can reduce wages in two ways with H-1B visa holders, viz, (1) pay H-1B workers less than comparable US workers and (2) hire younger H-1B visa holders rather than US workers older than 35. Employers use what some call legal “loopholes” in H-1B legislation to achieve these wage savings lawfully.

The first saving from H-1B workers arises because prevailing wages are defined in terms of the job being filled rather than the worker who fills the job. This allows an employer to advertise and specify bachelor’s degree required, master’s degree preferred. If a foreigner with a master’s degree is hired to fill the job, the employer gets master’s skills for bachelor’s wages. Furthermore, market wages are often higher than so-called prevailing wages for workers with particular hot skills – and job descriptions are often written to require particular computer language skills, with additional skills a plus. Employers do not have to pay the market wage for the job, only the higher of the prevailing or actual wage paid to similar US workers.

The second wage saving arises from hiring younger workers paid at the low end of the wage scale in an occupation. In 2003, the age distribution of H-1B workers in computer science and electrical engineering centered on age 29-30, while the age distribution of all workers in these fields centered on 40. Some employers say they prefer to hire recent graduates to obtain workers with the freshest skills, while critics say that employers prefer recent graduates to pay lower wages. Retraining older US workers could cost more because older workers may expect higher salaries and have higher benefit costs, and employers are unable to prevent retrained US workers from moving to another employer after being retrained.

There are many calls for government action to increase the number of engineers--the stock of engineers inside national borders is believed to be a key driver of innovation and economic growth. He reported that, of the almost 1.6 million US engineers in 2010, almost half were civil, mechanical, or industrial, and over half worked in manufacturing and construction. About 75,000 US engineers, less than five percent, were engaged in scientific research and development services.

China is graduating more engineers than the US, 660,000 in 2008 versus 100,000 in the US, but only 66,000 Chinese engineering graduates with bachelor’s or master’s degrees are considered qualified to work for multinationals, versus 80,000 US engineering graduates with bachelor’s or master’s degrees, that is, the US graduates more “qualified” engineers each year than China. The increase in the number of engineers in China might be expected in light of the expansion of Chinese industry and infrastructure.

Labor markets guide student career choices, albeit with lags. When the demand for petroleum engineers sagged in the 1980s, salaries stagnated and fewer students enrolled. When salaries jumped, enrollments rose, more than doubling between 2005 and 2010. Almost all undergraduate US petroleum engineering graduates are Americans, but most of the master's degree petroleum engineering students are foreigners.

The labor market for those earning PhDs in the biosciences has changed. In the mid-1970s, over half of the bioscience PhDs had tenure-track jobs at universities within five years of graduation; today, fewer than 15 percent do. The share of bioscience PhDs in industry has risen, but to less than 25 percent, so that most bioscience PhDs are in a variety of post-docs and other jobs, signifying a rather bleak job market for newly minted PhDs.

Union leaders emphasize that US workers are not protected under H-1B regulations, where the prevailing wage can become the minimum wage. They urge the creation of a commission to study US labor markets and make recommendations on the number of foreigners admitted. Employers of foreign workers want DHS to reduce the uncertainty in the current system by developing a trusted-employer program that includes simplified and expedited processing of requests for H-1B and other foreign workers and immigrants and issue visas automatically to foreigners who earn advanced degrees from US universities.

### **Conclusions**

Simple solutions to complex problems often create new problems. Australia gave foreign graduates of local universities a fast-track to immigrant status and found entrepreneurs creating programs that offered "easy and guaranteed" immigrant status via cooking and other educational programs not necessarily associated with innovation and economic growth. Markets that rely on salary signals seem to work as expected for US students in fields such as petroleum engineering, but function less well for foreigners earning PhDs in the biosciences, where the goal may be both a job and an immigrant visa. Opening doors wider to foreigners in foreigner-dominated fields of study, such as graduate studies in S&E, may aggravate "shortages" of US students who respond to salary and job signals and move into other fields.

The call for more S&E brains inside national borders is a form of human capital mercantilism that runs counter to many other features of globalization, including the spread of scientific knowledge and innovation. It is very difficult to have discussions of the trade offs between competing goods in S&E and other fields where immigration affects both US workers and firms. Furthermore, it is hard to educate Americans about the trade offs involved in immigration, such as the fact that the savings to a typical household from having mostly immigrant farm workers with below-poverty level incomes pick fresh fruits and vegetables saves the typical US household \$16 a year. Low-wage immigrants provide savings, but they are small.



There are often unintended consequences of migration policy decisions, from the failure of the creators of the H-1B program in 1990 to consider the emergency of IT staffing firms or body shops to the possible use of DHS's OPT STEM categories becoming the official government definition of STEM. Once an unanticipated development occurs in migration, it can be hard to reverse, as with IT staffing firms whose business model is based on hiring H-1B workers at relative low wages and shifting them from one US employer to another.

## **Agenda**

### **Dynamics of the S&E Labor Market: Projections, Regulations, and Employment Patterns**

Hosted by ISIM at Georgetown University  
Mortara Center for International Studies  
3600 N Street, NW  
Washington, DC 20057

**Monday, July 11, 2011**

The purpose of this workshop is to review projections of the demand for and supply of S&E workers, regulations governing the admission of foreign S&E workers and employers, and hiring patterns in S&E labor markets. The workshop will discuss how projections are made and evaluated; current OPT, H-1B and PERM regulations and proposed changes; S&E employer hiring patterns and S&E worker experience over the business cycle. We plan another workshop on the impacts of foreign S&E students and workers.

Speakers will make 10-15 minute presentations, followed by discussion of the presentations made in each session. We are grateful to the Sloan Foundation for support of this workshop.

**8:15 Breakfast**

**9:00 Welcome and Introductions**

**9:15 Projections of S&E Workers**

**10:30 Break**

**10:45 Regulating the Admission of Foreign S&E Workers: OPT, H-1B, PERM**

**12:00 Lunch**

**1:00 Employer Hiring Patterns in S&E Labor Markets: the Natural Sciences, Engineering, and IT**

**2:30 Break**

**2:45 Perspectives from Employers, Unions, and Congress**

**4:00 Summary and Conclusions**