ITIF

The Information Technology & Innovation Foundation

The Real Story on Guestworkers in the High-skill U.S. Labor Market

BY ROBERT D. ATKINSON AND LUKE A. STEWART | MAY 2013

High-skill immigration needs to be a key component of our nation's talent strategy, at least until we do a better job of producing more domestic STEM graduates.

The issue of high-skill immigration, including workers on H-1B visas, is receiving increased attention as Congress considers comprehensive immigration legislation. Underlying this discussion is a set of questions related to the labor market for high-skill workers, including science, technology, engineering and math (STEM) workers. These questions include: is there a shortage of STEM workers in the U.S. economy? Are STEM jobs growing faster than non-STEM jobs? Is the U.S. education system producing enough graduates with requisite STEM education? If not, is an increase in high skill immigration the answer? And finally, does high-skill immigration negatively affect the domestic supply of STEM talent?

As ITIF has demonstrated in the past, the United States faces a shortage of STEM workers.[1] STEM jobs are growing faster than non-STEM jobs, particularly in IT occupations.[2] The U.S. education system is not producing a sufficient number of graduates with STEM degrees, particularly graduates who are U.S. citizens or permanent residents.[3] High-skill immigration needs to be a key component of our nation's talent strategy, at least until we do a better job of producing more domestic STEM graduates. And high-skill immigration does not negatively affect the domestic supply of STEM talent.[4]

A number of groups, however, have challenged these findings. Most recently, the Economic Policy Institute (EPI) issued a report, *Guestworkers in the High-skill U.S. Labor*

Market, which concludes that there is no problem in the U.S. domestic STEM system other than too many high-skill foreign guestworkers.[5] Unfortunately, the report suffers from a number of major flaws, including the misinterpretation of education data, unlabeled charts, cherry-picking of a select few poorly-performing IT occupations, and a misreading of IT labor market signals. As this ITIF report shows, the EPI report's conclusions are simply not supported by the evidence. In fact, high-skill guestworkers are a complement, not a substitute, to American labor in the IT industry.

How do we explain such divergent conclusions? The answer is that this is not really a debate about immigration; this is a debate about fundamental goals. EPI's goal is a "fairer" distribution of U.S. income. ITIF's goal is faster GDP growth and increased U.S. competitiveness. In EPI's view, reduced high-skill immigration will reduce the supply of high-skill workers, thereby forcing corporations to bid up wages for U.S. STEM workers. In ITIF's view, this relationship is tenuous to begin with, given the increased global market for technology products and services. More importantly, reduced high-skill immigration would come at a substantial cost: lower U.S. innovation, productivity and competitiveness, and, in turn, fewer jobs for U.S. residents.

If one is going to advocate for policies to limit high-skill immigration, the first task is to convince policymakers that there is no real problem.

The EPI argument is based on three key assertions, all of which are incorrect. The first is that the United States has an adequate supply of STEM graduates and workers. The second is that U.S. demand for STEM workers, particularly in IT, is not growing. And the third is that IT wages are not growing, therefore providing evidence that there is no shortage of workers. As we show below all of these assertions are either wrong or misleading.

EPI CLAIM: THE UNITED STATES HAS A SUFFICIENT NUMBER OF HIGH-SKILL GRADUATES

If one is going to advocate for policies to limit high-skill immigration, the first task is to convince policymakers that there is no real problem. In other words, if it turns out that the United States already produces enough STEM graduates, then there is no need to for high skill immigration. To make this case, the EPI relies upon three main claims, none of which turn out to be true.

U.S. "High-Performing" Students are Not Good at Math

The EPI report argues that the United States provides a large share of the OECD countries' supply of "high-performing" high school students.[6] Therefore, there is no real problem.

This is likely true, but largely meaningless. The United States also accounts, for example, for a large share of the annual deaths in the OECD, but this doesn't mean that Americans are any less healthy; rather, it means we have a large share of the OECD population. That is why all meaningful international comparisons "normalize" measures using factors like GDP or population to gauge relative performance. The same logic applies to "high-performing" students. Stating simply, as the report does, that the United States has a lot of high-performing students bears no meaning on whether or not this is a sufficient supply for the United States' high-skill labor market, which, of course, is very large as well. The U.S. student population and the U.S. labor market are both large.

So what's the real story? Unfortunately, in this and many other instances, the report does not provide a direct source to its data nor does it provide a definition of "high-performing," so we are forced to work with the numbers that the report's chart provides.[7] This restriction means that we cannot present the number of high-performing students as a share of each country's student population. However, what we can do is make the assumption that, if Country A has 10 percent of the OECD's student population, then we can roughly expect it to also have 10 percent of the OECD's high-performing students. If, in reality, country A has 20 percent of the OECD's high-performing students, then it is over-performing, and if it has only 5 percent, then it is underperforming.

The report presents three categories of student aptitude: science, mathematics, and reading. Using the methodology described above and the countries that are labeled in each category, the United States performs relatively well in two of them.[8] In 2006, the United States had 26.4 percent of the OECD's student population. According to the report, it was home to 33.7 percent of the high-performing students in reading and 33.0 percent of the high-performing students in science, a difference of +7.3 and +6.6 percentage points, respectively. However, it should be noted that Mexico and Turkey are included in the OECD and both are low to middle-income nations with much lower levels of high-performing students. Removing these two nations from the mix and the United States share of high performing students is very close to its share of population. However even without this adjustment, in mathematics, the United States is far underperforming, with just 14.1 percent of the OECD's high-performing math students, a difference of an -12.3 percentage points. (Figure 1)

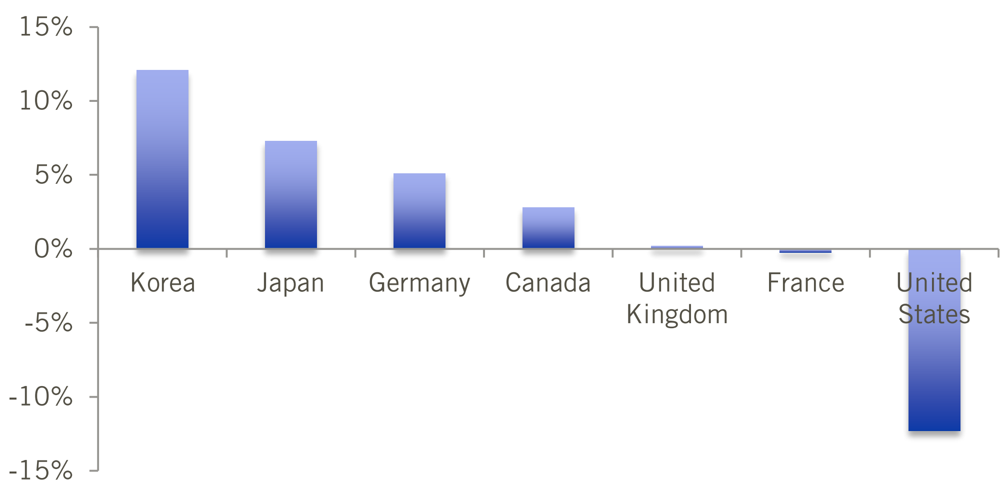

Figure 1: Percentage point difference between the U.S. share of OECD countries' high-performing mathematics students and the U.S. share of OECD countries' total student population, 2006[9]

This matters because while reading and science certainly are important mathematical aptitude is the most fundamental building block for STEM degrees, particularly in computer science. Indeed, the EPI report focuses almost exclusively on the IT industry, the underlying principles of which are mathematics-based. If U.S. students are underperforming in math, which they are, then claims of an insufficiently prepared workforce are far less easy to dismiss.

The EPI report also argues that, because mathematics test scores on the National Assessment of Educational Progress (NAEP) in the United States are improving, all is well. They tout the fact that math scores for white 17 year olds increased 4 points between 1973 and 2009. However, this is an increase of just 2.7 percent over 36 years. They also point to larger gains in test scores by black and Hispanic students. This is true, and is a positive development, yet their test scores still lag the scores of white students by between 15 and 19 percent.[10]

There is a "Leaky STEM Pipeline" in Post-secondary Education

Not only does the EPI report claim that we have a disproportionally large pool of STEM-ready high school graduates, it claims that "the pool of STEM majors actually increases between freshman year and graduation," and thus the common assertion that STEM students lose interest in STEM fields as they progress through college (the so-called "leaky STEM pipeline") is untrue. To demonstrate this, they show the number of STEM freshmen within the 2003/2004 beginning bachelor's degree cohort, and then show the number of STEM bachelor's degrees awarded to that same cohort of students. The number of STEM bachelor's degrees awarded is slightly higher than the number of STEM freshmen, suggesting that there is no leaky pipeline.

Of all the students in the 2003/2004 beginning bachelor's degree cohort that entered a STEM major at any time, 48.3 percent of them later left the STEM major.

Unfortunately, this analysis is flawed. The problem is that not all students declare their major upon enrollment or in their freshman year. Many wait until their sophomore or junior years to declare their major. According to the National Center for Education Statistics (NCES) (the same study that the EPI report used for its data[11]), 63.8 percent of STEM bachelor's students entered their STEM major in their freshman year, while the rest—over a third—waited until later academic years to either declare their STEM major or switch into a STEM major from a non-STEM major.[12] Saying that the number of STEM degrees is greater than the number of STEM freshman does not disprove the existence of "leaky STEM pipeline"; for any university degree, there can easily be more bachelor's degrees than freshman, because many students do not declare their majors in freshman year.

In fact, of all the students in the 2003/2004 beginning bachelor's degree cohort that entered a STEM major *at any time*, 48.3 percent of them later left the STEM major, either switching to a non-STEM major (28.1 percent) or leaving post-secondary education altogether (20.2 percent). (Figure 2) Importantly, this captures students that switched into a STEM field from a non-STEM major. This is the leaky STEM pipeline.

The "switch out" phenomenon is a problem that plagues STEM more than other fields. Seymour and Hewett document that 44 percent of STEM majors switch out of STEM sometime in their college career, verses 30 percent of humanities majors that switch out of the humanities.[13] (The STEM numbers would have been far worse had Seymour and Hewett included health profession majors and computer sciences in their list of STEM subject areas, for in computer and information sciences, the attrition rate is even higher, at 59.2 percent.)[14]

As ITIF has shown in a prior report, there are a number of reasons for this, including the fact that the average grade in college STEM courses is lower than in humanities and social science courses, the poor quality of lecturers in the first years of college STEM courses, the lack of exposure to laboratory work until later years, and because the work itself is harder.[15]

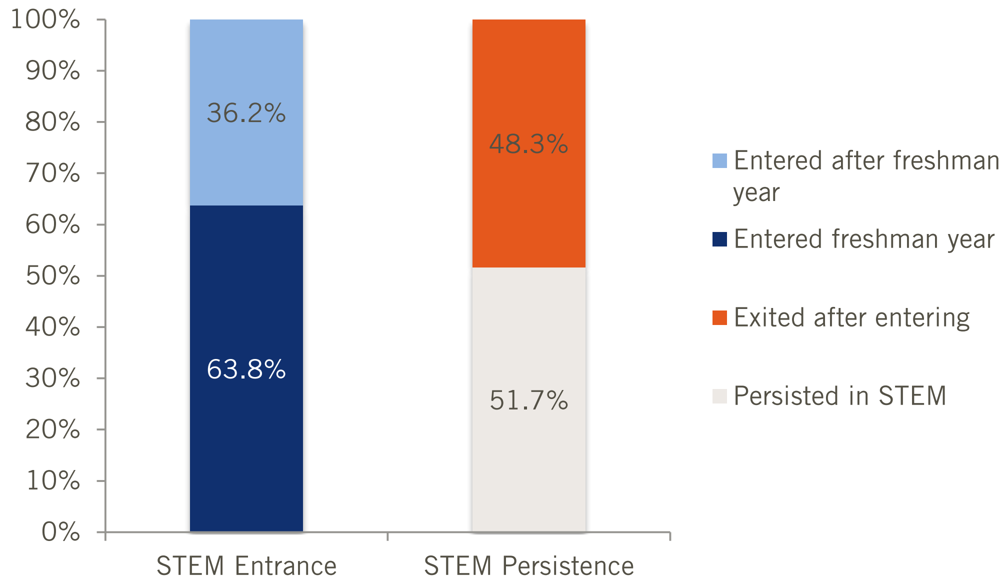

Figure 2: The "leaky STEM pipeline" entrance into STEM majors between 2003 and 2009 and persistence after entering, 2003/2004 beginning bachelor's degree cohort[16]

Moreover, from 2000 to 2007, non-STEM bachelor's degrees grew 24 percent, compared to just 16 percent for STEM bachelor's degrees. We see the same pattern for master's degrees. STEM master's degrees awarded increased by about 2 percent per year from 1993 to 2007, which is about half of the annual growth rate in the total number of master's (4 percent). And, while Ph.D. level production increased somewhat faster, number of doctoral degrees awarded increased by about 2.5 percent per year from 1993 to 2007, which is lower than the 3 percent annual growth rate in the number of non-STEM Ph.Ds.[17]

STEM and Computer Science Graduates are Getting the Jobs They Want

After the EPI report claims that the United States has more qualified STEM high school students and that there is no leaky STEM pipeline, it then asserts that with this plethora of well qualified STEM graduates, there is a surfeit of STEM jobs waiting for them. To support this claim, the report presents a series of charts showing that some STEM graduates are not working in the field of their major. Indeed, this is true. But, what the report does not do is provide any sort of baseline for comparison. In other words, while, yes, some STEM graduates do not work in the field of their major, how does this compare to other majors? Are STEM graduates more or less likely to work in the field of their major than graduates as a whole?

Analyzing NCES data, it turns out that STEM graduates are significantly more likely than average to work in the field of their major. As Figure 3 shows, 72.5 percent of employed graduates with a bachelors' degree in any field are working in a job related to their major, while 81.2 percent of STEM bachelor's graduates are working in a job related to their STEM major.[18] Therefore, the fact that some STEM students are working outside their major is far less worrying than it appears in the EPI report—the market actually appears more likely to draw a STEM graduate into his or her field than it would for the average graduate.

STEM graduates are significantly more likely than average to work in the field of their major.

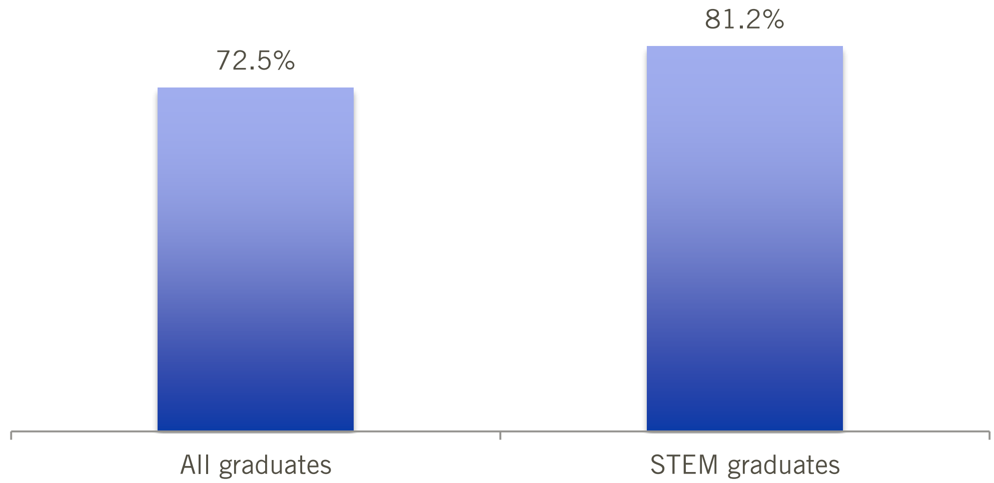

Figure 3: Percentage of employed 2007-2008 first-time bachelor's degree recipients who consider their job related to their undergraduate major, 2009[19]

Looking at specific majors, the story is the same. (Figure 4) Outside of the health care and education fields, graduates in STEM majors such as engineering and computer science are substantially more likely to have jobs related to their majors. While business does beat out "other STEM fields," (which includes biological sciences, physical sciences, mathematics and agricultural majors), it is important to note that "business" is a relatively general degree, and thus would relate to a wide range of private sector occupations.

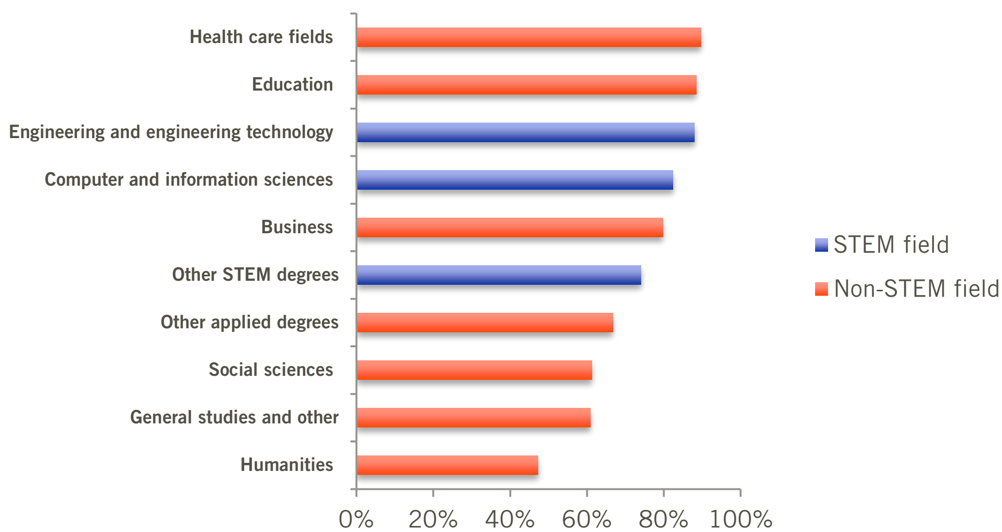

Figure 4: Percent of employed 2007-2008 first-time bachelor's degree recipients who consider their job related to their undergraduate major, by major, 2009[20]

STEM graduates are also less likely to be unemployed, and also report higher incomes than graduates in general, as Figures 5 and 6 below illustrate. Moreover, note that this data is looking at student outcomes in 2009—not exactly America's most healthy year in terms of employment. In other words, the evidence shows the exact opposite of the EPI's conclusion. There are plenty of jobs for STEM graduates.

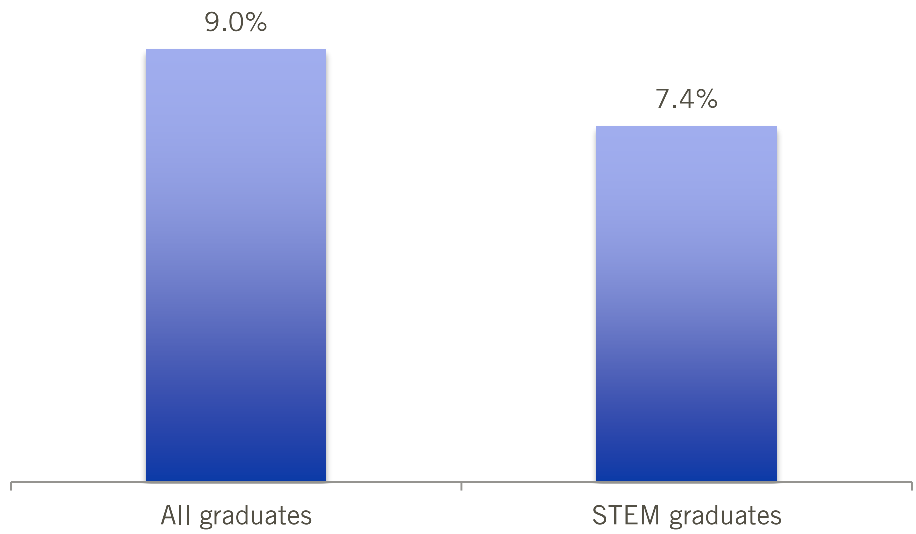

Figure 5: Percent of unemployed 2007-2008 first-time bachelor's degree recipients, 2009[21]

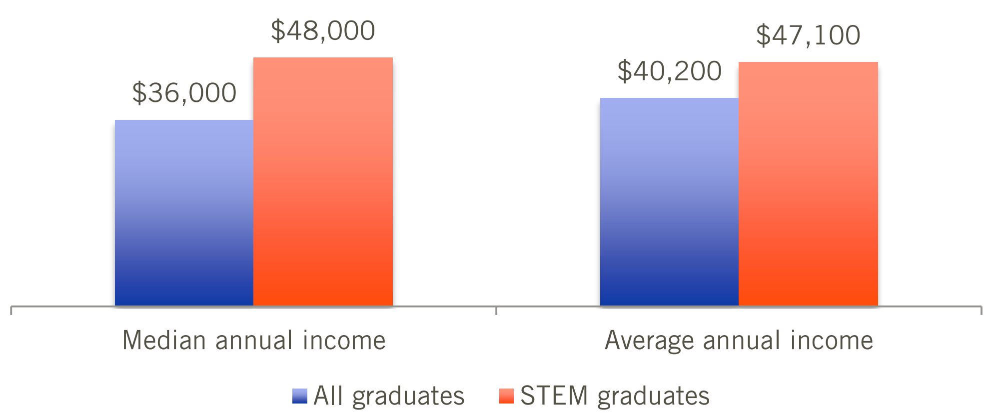

Figure 6: Median and average annual incomes of 2007-2008 first-time bachelor's degree recipients, 2009[22]

The EPI report then moves on to discuss the primary reason for STEM graduates not working in the field of their major. They provide a chart showing just a few STEM major fields—computer and information sciences, and engineering and engineering technology—and do not provide a baseline for comparison with non-STEM majors. What they show is that, among computer and information science majors who do not work in a field related to their major, 52.7 percent report that it is due to "pay, promotion, or working conditions," and 31.6 percent report that it is due to "job not available." For engineering and engineering technologies majors, those numbers are 31.3 percent and 30.2 percent, respectively. Therefore, they conclude that low wages in IT jobs are the reason for these qualified IT graduates to not work in their field.

Besides the fact that the EPI report shows just two majors and provides no baseline for comparison, there are further qualifications needed to provide context to the EPI figures: these are only graduates that are employed and only graduates employed in jobs they consider unrelated to their major. What the EPI report effectively hides is the relative labor market outcome for STEM graduates compared to all graduates on average. We have already shown that STEM graduates are more likely to be employed in than graduates in general, and are also more likely to be employed in fields related to their major. So, let's take every post-baccalaureate student in the NCES study and look at his or her reported labor market outcome.

STEM graduates are also less likely to be unemployed, and also report higher incomes than graduates in general.

Figure 7 shows that on every labor market outcome that could be objectively deemed generally "good" or generally "bad," STEM graduates outperform relative to the baseline. (Figure 7 sums to 100 percent vertically for both "all graduates" and "all STEM graduates," and thus represent all outcomes in the study.) Let's work down the list. For graduates that are out of the labor force because they have gone on to pursue further education, STEM graduates outperform all graduates, 8.4 percent to 4.4 percent. For graduates that are out of the labor force for other reasons, the shares are about the same: 2.8 percent for STEM graduates, 2.6 percent for all graduates. For graduates who are unemployed, as we have shown, STEM graduates outperform with a 7.4 percent unemployment rate (in 2009) versus a 9.0 percent unemployment rates for all graduates. For graduates employed in jobs related to their major, STEM graduates outperform 66.1 percent versus 61.0 percent for all graduates. For graduates in jobs unrelated to their major: in every single reason category, including "pay or promotion opportunities," "working conditions," and "job in field not available," STEM graduates outperform graduates in general. What this means is that, unequivocally, *graduates in STEM fields have superior labor market outcomes than graduates in general*. Period.

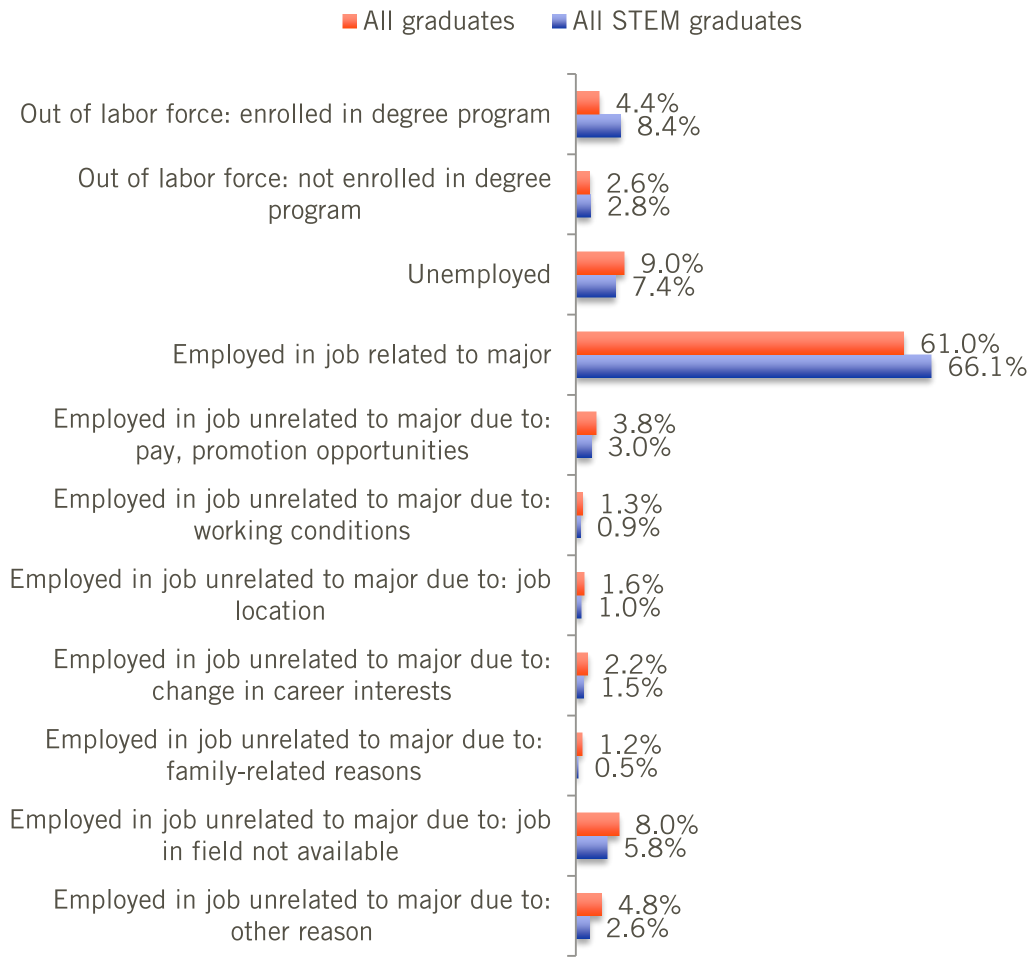

Figure 7: Labor market outcomes of 2007-2008 first-time bachelor's degree recipients, 2009[23]

For the sake of comparability with the EPI report, Figure 8 shows the labor market outcomes of computer and information sciences graduates and engineering and engineering technology graduates compared to the outcomes of all graduates. With one minor exception, the two STEM graduates outcomes are superior to the all graduate outcomes in every category. (Not all relatedness categories could be broken down in this chart, because the data did not meet the NCES's reporting standards; instead, these are included in the "all other reasons" category.) The exception is the 6.0 percent of computer science graduates report that they work in a job unrelated to their major due to "pay or promotion opportunities," versus 3.8 percent for all graduates. However, this exception needs to be put into context: 1) far more computer science graduates are working in a job related to their major (73.2 percent) than compared to the all-graduate baseline (61.0 percent); 2) the unemployment rate for computer science graduates is the lowest of the three fields; and 3) this could also indicate that computer science graduates found better pay and promotion opportunities elsewhere—on Wall Street, for example—not that pay or promotion were objectively deficient in computer science jobs.

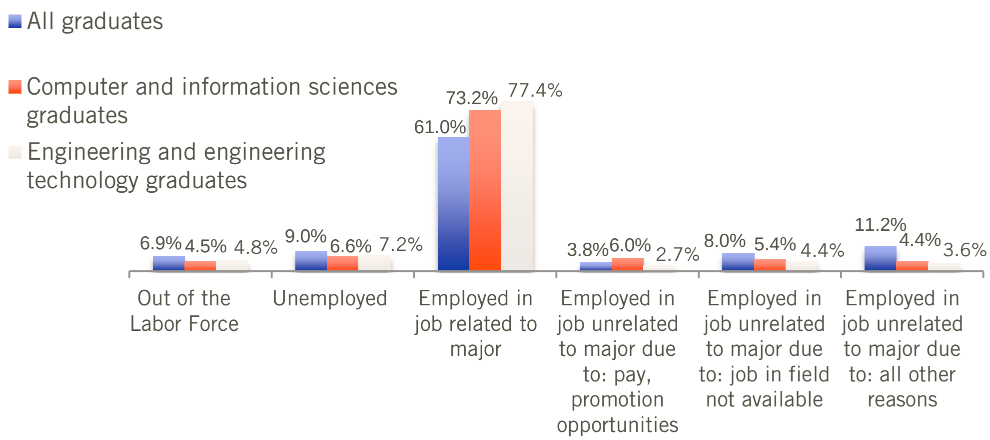

Figure 8: Labor market outcomes of 2007-2008 first-time bachelor's degree recipients, selected fields, 2009.[24]

On every labor market outcome that could be objectively deemed generally "good" or generally "bad," STEM graduates outperform relative to the baseline.

EPI CLAIM: INFORMATION TECHNOLOGY EMPLOYMENT IS FALLING

After claiming—falsely—that the U.S. domestic STEM supply is strong, the EPI report then argues that demand is weak. It claims that IT employment is below its 2002-2003 peak, and uses this as evidence to support its claim that there simply are not enough jobs for high-skill graduates in IT.[25] Let's analyze this claim by looking at occupation data in the Census Bureau's and Bureau of Labor Statistics' Current Population Survey. With this data, we can look at employment growth in IT occupations between 2003 and 2010. (We are limited in our time frame because the study changed its occupation classifications in 2003 and again in 2011, and thus data before and after these dates are not perfectly comparable.) What we find is that in contrast to EPI's claims, the number of IT workers in the U.S. economy has grown significantly.

First, let's look at the top-line numbers: the change in IT workers versus all workers between 2003 and 2010.[26] Figure 9 shows that over that time period, the number of workers employed in IT occupations grew by 19.1 percent, nearly 570,000 IT jobs, while the number of total employed U.S. workers fell by 0.8 percent.

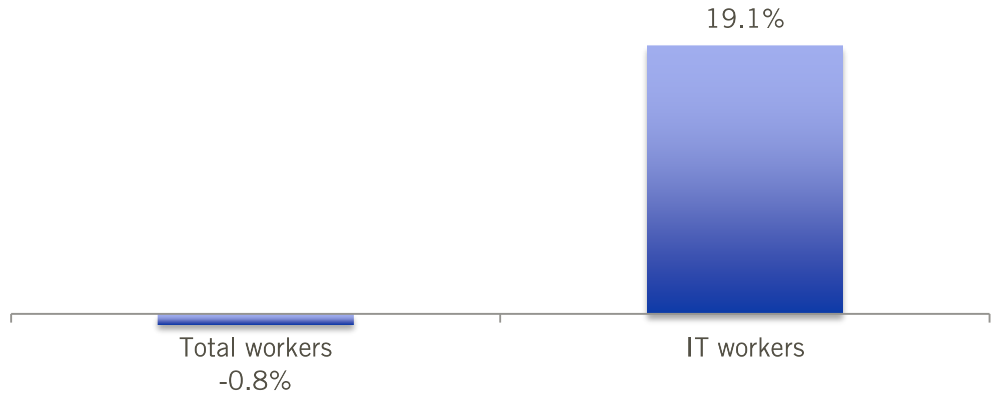

Figure 9: Percentage change in the number of IT workers vs. all workers in the United States, 2003-2010[27]

Over the past decade, IT jobs have not only increased, but have increased significantly faster than U.S. jobs as a whole.

The situation has not changed since the Current Population Survey's occupation classifications changed. Figure 10 shows the change in the number of IT workers compared to all workers as the U.S. economy slowly recovered over one year between 2011 and 2012.[28] Again, IT job growth outpaced job growth in general, 3.6 percent to 2.3 percent, respectively.

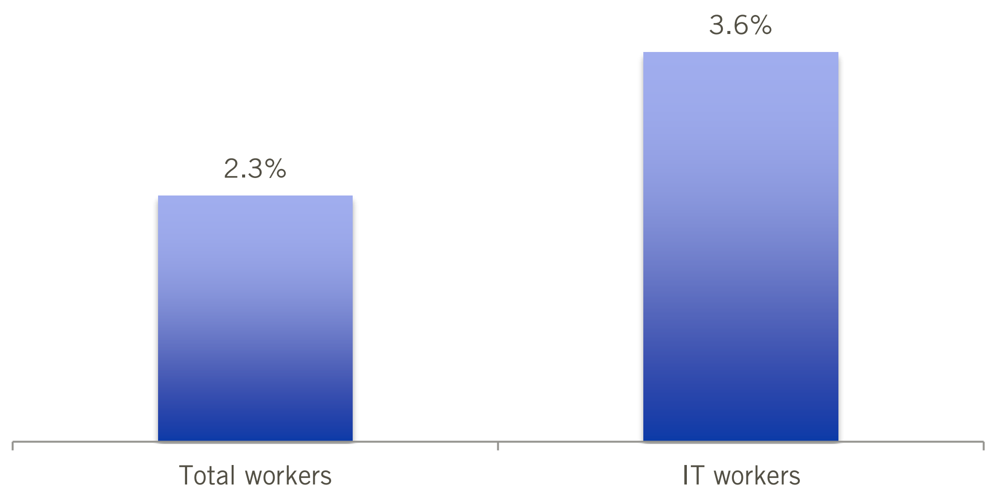

Figure 10: Percentage change in the number of IT workers vs. all workers in the United States, 2011-2012[29]

The evidence is clear. Over the past decade, IT jobs have not only increased, but have increased significantly faster than U.S. jobs as a whole.

Now, let's look at specific IT occupations. Figure 11 shows the occupational composition of IT workers in the United States. In 2010, software developers (not programmers) account for the largest share of IT jobs, 27 percent, followed by computer scientists and systems analysts (19 percent), computer and information systems managers (14 percent), computer programmers (12 percent), computer support specialists (10 percent). Aggregated under "All other computer occupations" are network systems and data communications analysts (8 percent), network and computer administrators (6 percent) and database administrators (3 percent). It is important to note that computer programmers account for just 12 percent of IT workers, because in two charts in the EPI report, computer programming is the only IT occupation displayed.[30] This matters because, computer programming, as the EPI report admits, is among the lowest skilled of the IT occupations, and thus is more prone to offshoring. Showing only the computer-programming component might lead readers to believe that the IT labor market is less healthy than it actually is, given that 88 percent of IT workers are not computer programmers. (This ratio, 12 percent to 88 percent, is the same in 2012 under the new occupation classifications.)

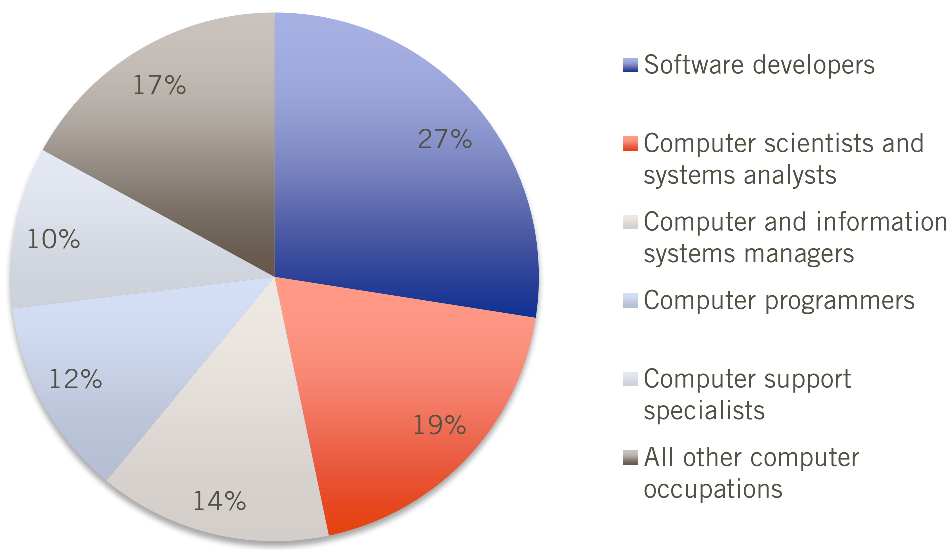

Figure 11: Occupational composition of IT workers, 2010[31]

In the software industry, it is in software development, not programming, that the United States has a competitive advantage. Figure 12 shows the trend in IT job growth between 2003 and 2010. All IT occupations except for computer programmers added jobs. There were 272,000 more software developers in 2010 than there were in 2003. Likewise, there were 174,000 more computer and information system managers—another high-skill occupation—in 2010 than in 2003. Meanwhile, the number of computer programmers fell by 63,000—again, this was the only IT occupation category to decline. For EPI to focus so much of their analysis on this one sub-occupation is to distort the overall trends in IT occupation growth.

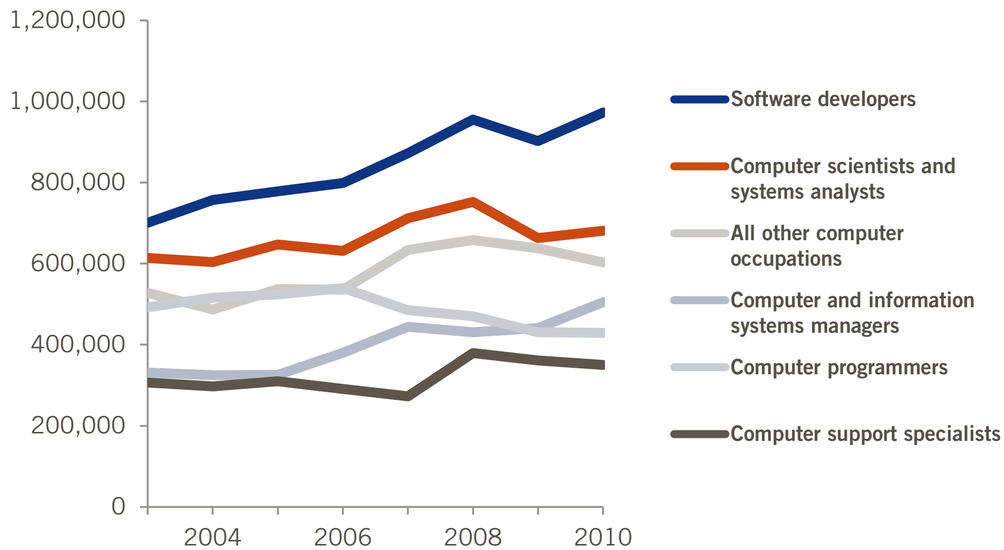

Figure 12: Trend in the number of IT workers by IT occupation, 2003-2010[32]

Every IT occupation except for computer programming exceeded the economy-wide average in job growth between 2003 and 2010.

The fast growth in almost all IT occupations is even clearer when we contrast them with the growth in workers as a whole. Figure 13 converts these growth trends to an index, starting each occupation at a base of 100 in 2003, and then following its growth off that base through to 2010. Every IT occupation except for computer programming exceeded the economy-wide average in job growth between 2003 and 2010.

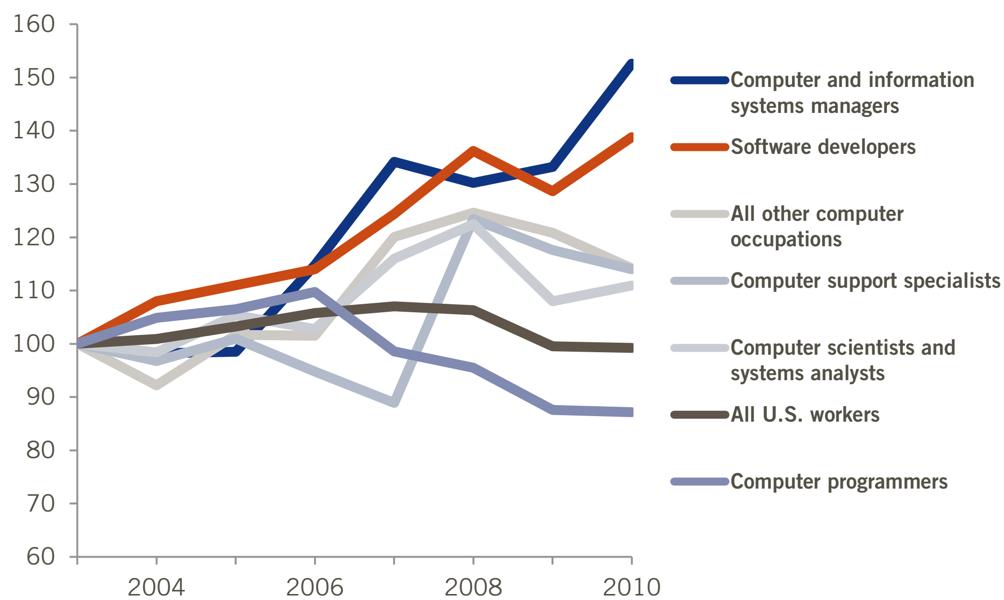

Figure 13: Trend in the number of IT workers by occupation versus the trend for all U.S. workers, 2003-2010[33]

In summary, IT jobs are growing. They have grown since the burst of the dot-com bubble. And they have grown significantly faster than U.S. jobs as a whole. To say otherwise is incorrect.

EPI CLAIM: LOW WAGES DEPRESS STEM WORKER SUPPLY

Even if STEM jobs (including IT) are growing, the supply of workers may not keep up. Even though EPI claims that there are adequate numbers of STEM, they also argue that if STEM wages were higher, more STEM workers would work in their field. EPI's argument is that the lack of wage growth dissuades high-skill U.S. graduates from seeking STEM jobs, particularly IT and, related to this, that if we limited supply of STEM workers (by reducing the supply of high-skill guestworkers), then wages for U.S. STEM jobs would increase, pulling more qualified workers into STEM jobs.

We have already shown that STEM and, in particular, computer science graduates have superior labor market outcomes than other students, so we will focus here on their analysis of the IT labor market. In short, the EPI report's claim about IT wages is overstated and misses the point.

Information Technology Wages are High and Overall Growing Faster Than Median Wages for All Jobs

The EPI report not only claims that IT job growth is flat, they claim that IT wage growth is flat. They use this to support their conjecture that the IT labor market is unhealthy by claiming that the IT labor market is just like any other labor market: if there were a lack of supply in workers, then wages should rise in response and these higher wages would pull in more workers. Let's examine these claims one-by-one.

First, is IT wage growth flat? The reality is significantly more nuanced than the EPI report makes it seem. (For example, the EPI report does not provide the economy-wide wage trend for comparison.) As shown in Figure 14, between 2003 and 2010, some IT occupations saw wage growth, while others saw wage decline. On the one hand, computer support specialists saw 7.1 percent growth in real (inflation-adjusted) wages, software developers (which comprises the largest share of IT jobs) saw 5.2 percent growth, and computer scientists and system analysts saw 2.8 percent growth. Not pictured, network and computer systems administrators saw 4.0 percent growth. These are significantly faster than overall U.S. wage growth, which was only 1.7 percent over the period.

On the other hand, other IT occupations saw real median wage decline: computer programmers saw a 3.5 percent decline and computer and information systems managers saw a 3.6 percent decline (however, this is already the highest paid IT occupation). Not pictured, database administrators saw a 1.8 percent decline and network and data communications analysts saw a 5.4 percent decline. However, as we showed in the pie chart (Figure 11) above, the number of workers in each of occupations is far from evenly distributed. In fact, given the distribution in the pie chart, in 2010, 63 percent of IT workers worked in an occupation that saw its real median wage increase faster than overall U.S. wage growth over the 2003-2010 period. Only 37 percent worked in occupations with real median wage decline. Overall, as EPI's own Ross Eisenbrey points out in an oped, salaries in computer- and math-related fields for workers with a college degree rose 4.5 percent between 2000 and 2011, 2.6 times faster than overall U.S. wage growth.[34]

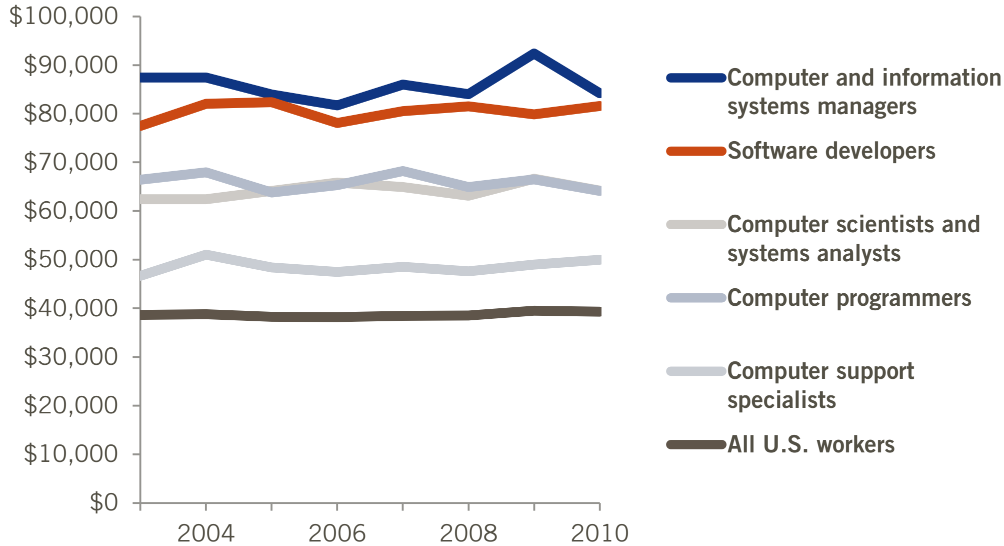

Figure 14: Trend in real median annual earnings (2012 dollars) by IT occupation, 2003-2010[35]

Salaries in computer- and math-related fields for workers with a college degree rose 4.5 percent between 2000 and 2011, 2.6 times faster than overall U.S. wage growth.

Moreover, IT wages are already much higher than the median wage for all U.S. workers. The EPI report ignores this fact, yet what do high-skill U.S. graduates look at when they enter the labor market? Do they look at how much more they could earn in an IT job right now, or do they analyze past wage trends to see if IT wages are going up a bit faster or slower than overall wages. In all likelihood, they focus much more on the earnings "premium" that an IT worker reaps. Figure 15 shows these premiums compared to U.S. workers that have earned a bachelor's degree. While computer support specialists and web developers do not see a wage premium over workers with a bachelor's degree, this is to be expected because according to the Bureau of Labor Statistics, these occupations do not typically require a bachelor's degree.[36] For those occupations that do typically a bachelor's degree, the premiums range from $4,118 per year for computer programmers to more than $28,000 per year for computer and information systems managers, on top of what they would earn in any occupation requiring at least a bachelor's degree. The average premium for a bachelor's IT worker compared to all bachelor's jobs is an extra $19,500 per year in earnings.

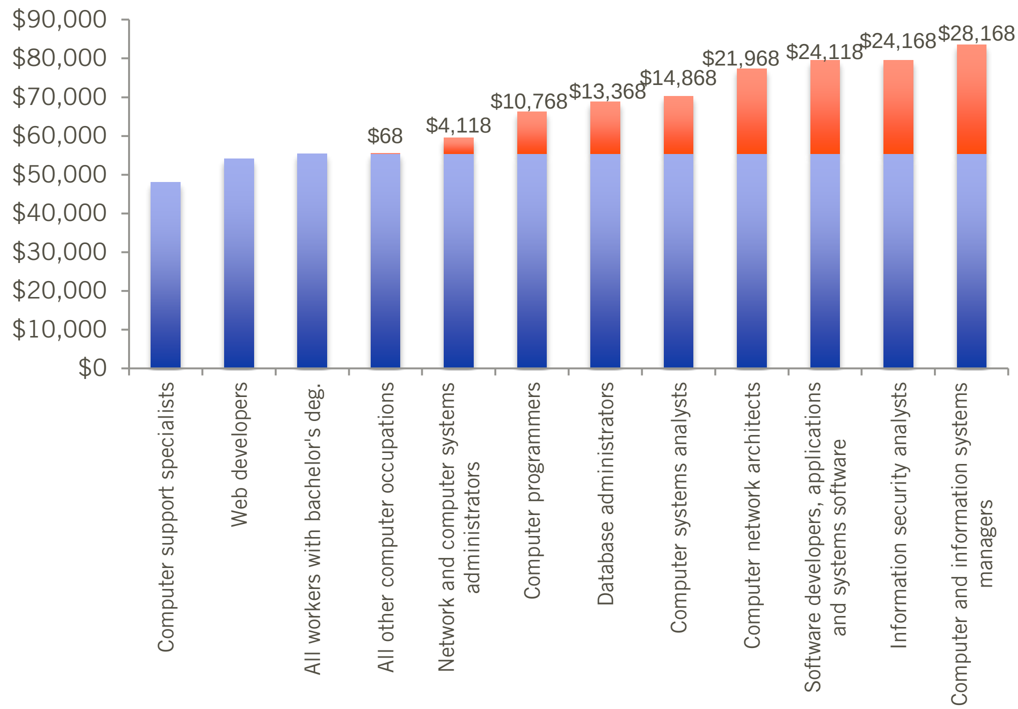

Figure 15: Median earnings and earnings premiums for IT occupation, compared to workers with a bachelor's degree, 2012[37]

Guestworkers Are Not Depressing IT Wages

The EPI report associates the purported slow growth in IT wages with the presence of guestworkers in the IT sector. This rests in part on the assumption that IT guestworkers make less than U.S. workers, and thus are essentially undercutting wages paid to all IT workers. However, this does not appear to be the case.

Some studies have found that H-1B workers earn less than domestic IT workers.[38] Other studies have found they pay the same or more. For example, Mithias and Lucas found, after controlling for human capital differences, IT professionals with an H-1B or other work visa earn on average 6.8 percent more annually than IT professionals who have U.S. citizenship. When they add additional controls for the state in which the IT professionals work and for job titles, the premium declines, but is still significant at 2.6 percent. Moreover, they also note that H-1B visa IT workers earn less than foreign IT workers with a green card, who make 12.9 percent more than workers with U.S. citizenship. But in either case, their evidence suggests that at least for their sample, H-1B visa workers are not being used by U.S. firms as a way to undercut the wages of domestic workers. As they state, "the year-wise results on salary premium for foreign professionals do not provide support for the notion that firms are misusing U.S. work visa provisions to pay less to foreign professionals. The presence of a significant salary premium for H-1B and other visa holders in 2000 when the H-1B cap was 115,000, but insignificant premium in 2001 when the H-1B cap went up to 195,000, appears to vindicate the IT industry's plea for raising the H-1B cap to make it easier to hire foreign professionals to overcome 'tightness' in the IT labor market."[39]

Another study on H-1B workers in IT showed similar results. After controlling for age, Lofstrom and Hayes found that new H-1B workers earned a salary premium of nearly 18 percent over U.S.-born workers, while renewing H-1B workers earned close to a 5 percent premium. After adding in other controls, including IT occupation and industry, they found that new H-1B workers earned close to 7 percent more than U.S.-born workers, with an additional 5 percent increase for H-1B workers renewing their visa.[40]

A cursory look at H-1B wages in IT reveals that, on average, they do earn less than the average IT worker.[41] However, figure 16 shows that, as with wages, the reality is more nuanced: the blue bar represents the average wage for all workers in an IT profession, while the smaller dark bar represents the range of H-1B worker salaries in that same profession. In some professions, such as computer programming, H-1B workers do indeed earn lower wages than the U.S. average. However, in others, such as software developers and computer scientists, H-1B workers earn more. Indeed, the pattern is very similar to the pattern in wages: lower-skilled IT jobs such as programming see H-1B workers earning less (along with low job growth, as discussed in the previous section), while higher-skilled jobs tend to see H-1B workers earn more or see a very small difference between H-1B wages and the average U.S. wage.

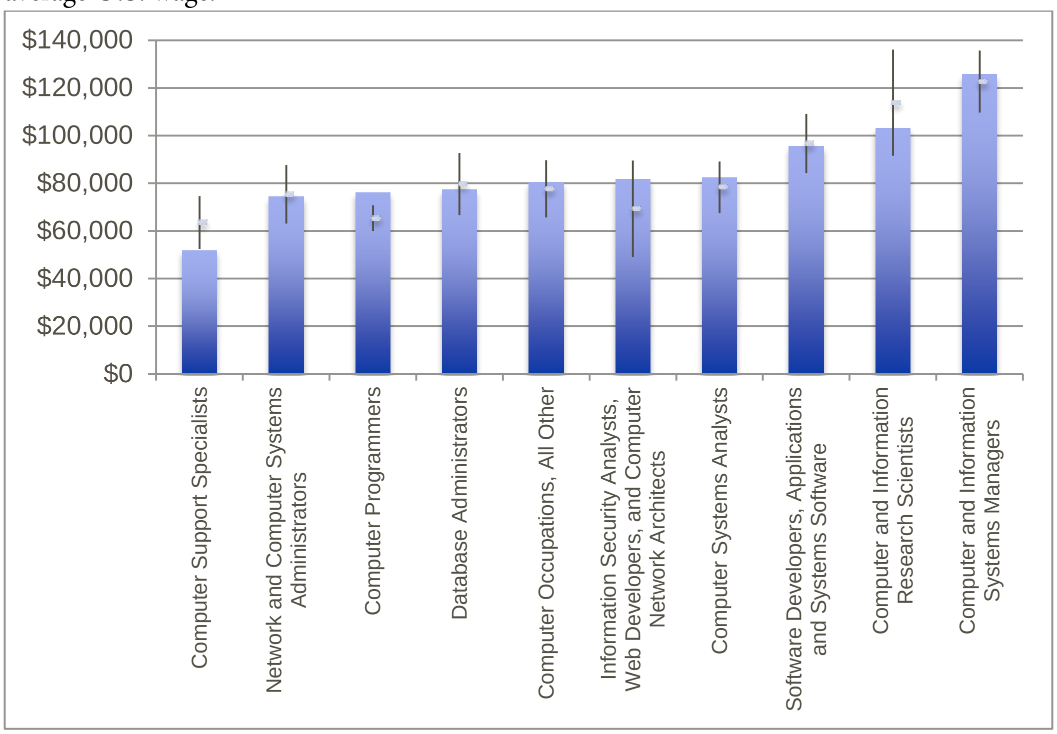

Figure 16: U.S. average IT annual salary versus range of H-1B IT annual salaries, 2011[42]

Thus, the argument that guestworkers are unequivocally depressing IT wages falls flat. As with wages, the picture is far more nuanced. Moreover, this evidence is particular poignant when combined with the fact that U.S. STEM and computer science graduates are more likely to be employed in jobs relating to their major than the average U.S. graduate. If employers were trading U.S. high-skill graduates for high-skill guestworkers, then we would expect high-skill graduates to see worse, not better, employment outcomes.

Recent IT Wage Growth Does not Imply a Labor Surplus

The fact remains that wage growth for IT workers is not nearly as impressive as job growth for IT workers (although, if they go into the IT field, graduates are all but guaranteed to have "high" incomes). The question is, does this matter? The answer is, not really, for two reasons.

First, EPI's assertions notwithstanding , the IT labor market does not behave like the average U.S. labor market for two reasons: first, many IT and STEM jobs are generally in industries that face global competition; second, IT and STEM jobs generally appear to require certain skills and aptitudes which are not widely distributed among the U.S. population.

On the first point, not only is a significant share of IT industry output traded globally, but the labor input can be easily traded as well. If a company needs someone to move its product from one city to another, they have no choice but to hire an American transportation worker. In contrast, if a company wants IT work done, often they can have that work done remotely, in another part of the country or in another country altogether. Computer programming, for example, can be outsourced to foreign nations such as India: American workers have an advantage in relatively high-skilled and high-paying software development, but workers in lower wage foreign nations can gain work in the lower end of this value chain. Indeed, when it comes to software, we see real wage increases in software development but real wage declines in programming. Database administration is another occupation in which we have seen real wage declines, because this is another occupation that can easily be transferred to lower skill, and lower paid, foreign workers.

In general, by the very nature of IT labor—in that much of the work can be done remotely—the IT labor market is one which can be traded. Hence, there are two dynamics going on that affect IT wages. First, occupations in which the United States holds a "knowledge" or "innovation" (in economics speak, "human capital") advantage can see real wage increases, while occupations that can be offshored may see real wage declines as these jobs must now compete with lower wage workers overseas. Moreover, even in occupations where the United States holds a stronger competitive advantage, such as with software developers, the pressures of global competition limit wage growth. If wages grow too fast here in the United States, it becomes more advantages to shift work at the margin to other lower cost nations. In contrast, occupations like law and medicine that largely serve domestic markets and where foreign competition is minimal do not face these limits. Any occupational shortages in these occupations would lead to higher wages, which would be borne by U.S. consumers of legal and health services.

On the second point, the EPI report assumes that IT and STEM occupations are generally similar to other occupations, with skills easily acquired and largely unrelated to personal characteristics. In this conception, all workers have the same outcomes on occupational interest tests and equal intelligences.[43] If wages for concert pianists rise, then according to the EPI authors, workers who otherwise might be software developers would instead witch their college major to music. Likewise, if wages for software developers rise (they are already very high), students who have a real talent and love for music would abandon that and switch to designing mobile apps.

The problem with the neoclassical economics labor market model that EPI employs is that it assumes that average wage increases mean no shortage, when it could just as easily be a reflection of a shortage that is addressed in a global marketplace. The neoclassical model works much better for occupations that are not globally traded. In professions such as law and medicine, in which licensing and the location-specific nature of work reduce vulnerability to foreign competition, wages increased faster than for STEM jobs, which are more exposed to international competition.

Moreover, some occupational choices are more responsive to wage changes if they involve fewer specialized skills to acquire and where the real choices of work are much broader. For example, if wages for general business occupations doubled there would likely be a significant increase in students majoring in business because the skills and orientation involved are broader and more widely held by more students than specialized skills like developing software. Likewise, in many occupations (like trucking and nursing), where skill acquisition is relatively straightforward (and often can be accomplished in a matter of months, rather than years), higher wages usually pull in more workers. But, for STEM occupations, skill acquisition is much more complicated, takes longer to attain, and requires a core set of skills on which to base further education that many students simply lack. (The poor performance of U.S. student in mathematics that we have shown is good example.)

For STEM occupations, skill acquisition is much more complicated, takes longer to attain, and requires a core set of skills on which to base further education that many students simply lack.

Finally, if more money drives more STEM degrees, then why do we see much more interest in high schools students in the arts than in STEM? It is not because high school students are deluded into thinking they can make a fortune in the arts. For example, enrollment in the music theory advanced placement test high school students test grew by 362 percent between 1997 and 2009, while enrollment in the Computer Science AB AP test grew by just 12 percent. Even Latin Virgil and French Literature AP test enrollment grew faster than Computer Science. In 2008, more than three times as many students took the Art History AP test as did the Computer Science AB test.[44] Clearly, wages much higher in computer science than in fine arts were not enough to convince more high school students to focus on computer science.

CONCLUSION

The EPI report attempted to paint a picture of a stagnant IT labor market, depressed by the presence of high-skill guestworkers that obtain jobs at the expense of U.S. citizens. But, they get the story wrong. High-skill guestworkers are a complement, not a substitute, for American labor in the IT industry. The number of IT workers in the United States is growing every year. U.S. STEM graduates have superior labor market outcomes—they are more likely to 1) have jobs, 2) have jobs related to their major, and 3) earn higher salaries than their non-STEM counterparts. IT pays a high salary premium over other jobs. IT guestworkers are not undercutting U.S. citizen's wages. And IT faces global competition in labor, which places a ceiling on IT wage growth. These are not signs of labor surplus, but rather of labor shortages.

High-skill foreign guestworkers provide fuel for the U.S. innovation economy that the United States cannot provide on its own. High-skill guestworker programs, such as the H-

The goal of economic policy should be overall economic growth, a "larger pie" via increased productivity, innovation and competitiveness, not a smaller pie with slightly higher wages for a few.

1B visa, help ensure that the best and the brightest from around the world come to the United States to deploy their skills, boosting the competitiveness and the innovative capacities of American companies and leading to the formation of new fast-growing American companies, which, in turn, improves the lives of everyday Americans and creates new jobs on American shores.

In the end, EPI's goal in this report (as in much of their work) is to advance an agenda of redistribution, with some Americans as workers getting more, and all Americans as consumers getting less (by having to pay higher prices). Public policies established to achieve nothing more than increase the wages of IT workers by restricting the supply of workers in the United States would have three effects. First, they would lead to higher prices for products and services that have IT as a significant input. This would be a transfer payment from all consumers to some workers. Second, they would reduce the competitiveness of establishments in the United States that use IT labor as a significant input, reducing jobs in America. And third, by raising the price of IT goods and services they would limit IT usage, thereby reducing productivity and innovation.[45] The goal of economic policy should be overall economic growth, a "larger pie" via increased productivity, innovation and competitiveness, not a smaller pie with slightly higher wages for a few. Ensuring an adequate supply of high-skilled, STEM labor, through both better domestic education and training policies and more liberal high-skill immigration policies is a key factor in achieving this goal.

ENDNOTES

1. Robert D. Atkinson and Merrilea Mayo, *Refueling the U.S. Innovation Economy: Fresh Approaches to Science, Technology, Engineering and Mathematics* (STEM) Education (Washington, DC: ITIF, 2010), http://www.itif.org/files/2010-refueling-innovation-economy.pdf.
2. Luke A. Stewart and Robert D. Atkinson, *Looking for Jobs? Look to IT in 2012 and Beyond* (Washington, DC: ITIF, 2012), http://www2.itif.org/2012-jobs-it.pdf.
3. Atkinson and Mayo, *Refueling Innovation Economy*.
4. Robert D. Atkinson, "H-1B Visa Workers: Lower-wage Substitute, or Higher-wage Complement" (technical report, ITIF, June 9, 2010), http://www2.itif.org/2010-h1b-visa.pdf.
5. Hal Salzman, Daniel Kuehn and B. Lindsay Lowell, *Guestworkers in the High-skill U.S. Labor Market: An Analysis of Supply, Employment, and Wage Trends* (Washington, DC: Economic Policy Institute, 2013), http://www.epi.org/files/2013/bp359-guestworkers-high-skill-labor-market-analysis.pdf.
6. Ibid., 6.
7. The data source listed on the relevant chart in the report (Figure B) provides no such data. However, an in-text citation leads to a 2008 Nature article ("Making the Grade") written by two of the three authors of the report we analyze here. While a chart of the numbers of "top performing" students in various countries is provided, precise numbers are not. (Moreover, "top performing" is not defined.) Following the data source listed on this chart leads to an OECD paper, "PISA 2006: Science Competencies for Tomorrow's World," but yet again, none of the data for the chart is there. Our best guess for the source of this data is the OECD's 2006 Programme for International Student Assessment (PISA) study.
8. The countries the report labels in the chart are not consistent across categories.
9. Salzman, Kuehn and Lowell, *Guestworkers*, 7; OECD, Education Statistics (students enrolled by age; accessed April 29, 2013), http://dx.doi.org/10.1787/edu-data-en; Canada's total student population estimated from prior-years' data.
10. National Center for Education Statistics, *Grade 12 Reading and Mathematics 2009 National and Pilot State Results* (Washington, DC: NCES, 2009), http://nces.ed.gov/nationsreportcard/pdf/main2009/2011455.pdf.
11. NCES 2003–04 Beginning Postsecondary Students Longitudinal Study, Second Follow-up.
12. National Center for Education Statistics, 2003–04 Beginning Postsecondary Students Longitudinal Study, Second Follow-up (table 1. Entrance into STEM and non-STEM fields; accessed May 2, 2013), http://nces.ed.gov/datalab/tableslibrary/home.aspx.
13. Elaine Seymour and Nancy M. Hewitt, *Talking About Leaving: Whey Undergraduates Leave the Science*s (Boulder, CO: Westview Press, 2000).
14. National Center for Education Statistics, 2003–04 Beginning Postsecondary Students Longitudinal Study, Second Follow-up (special tabulation; Students who entered STEM left these fields by spring 2009 by Time of entrance into STEM field, for Degree program 2003-04 [Bachelor's degree]; accessed May 6, 2013), http://nces.ed.gov/datalab/.
15. Atkinson and Mayo, *Refueling Innovation Economy*.
16. National Center for Education Statistics, 2003–04 Beginning Postsecondary Students Longitudinal Study, Second Follow-up (special tabulation; Students who entered STEM left these fields by spring 2009 by Time of entrance into STEM field, for Degree program 2003-04 [Bachelor's degree]; accessed May 6, 2013), http://nces.ed.gov/datalab/.
17. Atkinson and Mayo, *Refueling Innovation Economy*.
18. National Center for Education Statistics, 2008/09 Baccalaureate and Beyond Longitudinal Study (table 3.5. relatedness of postbaccalaureate job and bachelor's degree major; accessed May 6, 2013), http://nces.ed.gov/datalab/tableslibrary/home.aspx.
19. National Center for Education Statistics, 2008/09 Baccalaureate and Beyond Longitudinal Study (table 3.5. relatedness of postbaccalaureate job and bachelor's degree major; accessed May 6, 2013), http://nces.ed.gov/datalab/tableslibrary/home.aspx.
20. Ibid.
21. National Center for Education Statistics, 2008/09 Baccalaureate and Beyond Longitudinal Study (table 3.2. postbaccalaureate nonemployment; accessed May 6, 2013), http://nces.ed.gov/datalab/tableslibrary/home.aspx.

22. National Center for Education Statistics, 2008/09 Baccalaureate and Beyond Longitudinal Study (table 3.4. postbaccalaureate earned incomes; accessed May 6, 2013), http://nces.ed.gov/datalab/tableslibrary/home.aspx.
23. National Center for Education Statistics, 2008/09 Baccalaureate and Beyond Longitudinal Study (table 3.1. postbaccalaureate employment; table 3.2. postbaccalaureate nonemployment; table 3.5. relatedness of postbaccalaureate job and bachelor's degree major; accessed May 6, 2013), http://nces.ed.gov/datalab/tableslibrary/home.aspx;
24. Ibid.
25. Salzman, Kuehn and Lowell, *Guestworkers*, 22.
26. 2003-2010 IT worker occupation classifications: Computer and information systems managers; Computer scientists and systems analysts; Computer programmers; Computer software engineers; Computer support specialists; Database administrators; Network and computer systems administrators; and Network systems and data communications analysts.
27. Bureau of Labor Statistics, Current Population Survey (median weekly earnings of full-time wage and salary workers by detailed occupation and sex; accessed May 10, 2013), http://www.bls.gov/cps/tables.htm.
28. 2011-2012 IT worker occupation classifications: Computer and information systems managers; Computer and information research scientists; Computer systems analysts; Information security analysts; Computer programmers; Software developers, applications and systems software; Web developers; Computer support specialists; Database administrators; Network and computer systems administrators; Computer network architects; and Computer occupations, all other.
29. Bureau of Labor Statistics, Current Population Survey (median weekly earnings of full-time wage and salary workers by detailed occupation and sex; accessed May 10, 2013), http://www.bls.gov/cps/tables.htm.
30. EPI figure I (p. 19) and figure R (p. 28)
31. Bureau of Labor Statistics, Current Population Survey (median weekly earnings of full-time wage and salary workers by detailed occupation and sex; accessed May 10, 2013), http://www.bls.gov/cps/tables.htm.
32. Ibid.
33. Ibid.
34. Robert. D. Atkinson, "Yes Virginia, We Do Have a Need for More STEM Workers," *Innovation Files* (blog), February 10, 2013, http://www.innovationfiles.org/yes-virginia-we-do-have-need-for-more-stem-workers/.
35. Bureau of Labor Statistics, Current Population Survey (median weekly earnings of full-time wage and salary workers by detailed occupation and sex; accessed May 10, 2013), http://www.bls.gov/cps/tables.htm.
36. "Computer Support Specialists," in *Occupational Outlook Handbook* (Washington, DC: Bureau of Labor Statistics, 2012), http://www.bls.gov/ooh/computer-and-information-technology/computer-support-specialists.htm; "How to Become an Information Security Analyst, Web Developer, or Computer Network Architect," in *Occupational Outlook Handbook* (Washington, DC: Bureau of Labor Statistics, 2012), http://www.bls.gov/ooh/computer-and-information-technology/computer-support-specialists.htm;
37. Bureau of Labor Statistics, Current Population Survey (median weekly earnings of full-time wage and salary workers by detailed occupation and sex; Median usual weekly earnings, employed full time, wage and salary workers, bachelor's degree only, 25 years and over accessed May 10, 2013), http://www.bls.gov/cps/tables.htm.
38. For example, see Norman Matloff, *Are Foreign Students the 'Best and Brightest'?: Data and Implications for Immigration Policy* (Washington, DC: Economic Policy Institute, 2013), http://www.epi.org/files/2013/outstanding-talent-high-skilled-immigration.pdf.
39. Sunil Mithas and Henry C. Lucas, Jr., "Are Foreign IT Workers Cheaper? U.S. Visa Policies and Compensation of Information Technology Professionals," *Management Science* 56, no. 5 (2010): 745-765.
40. Magnus Lofstrom and Joseph Hayes, "H-1Bs: How Do They Stack Up to US Born Workers?" (working paper, Public Policy Institute of California, December 2011), http://ftp.iza.org/dp6259.pdf.

41. H-1B IT workers earn about $72,000 per year verses a U.S. average of $82,000 per year. See Department of Labor, Office of Foreign Labor Certification, Performance Data (LCA programs, FY 2011; accessed May 14, 2013), http://www.foreignlaborcert.doleta.gov/performancedata.cfm and Bureau of Labor Statistics, Occupational Employment Statistics (national employment, 2011; accessed May 14, 2013), http://www.bls.gov/oes/tables.htm. Author's analysis.
42. Department of Labor, Office of Foreign Labor Certification, Performance Data (LCA programs, FY 2011; accessed May 14, 2013), http://www.foreignlaborcert.doleta.gov/performancedata.cfm; Bureau of Labor Statistics, Occupational Employment Statistics (national employment, 2011; accessed May 14, 2013), http://www.bls.gov/oes/tables.htm. Author's analysis.
43. See "Occupational Interest Survey," Los Rios Community College District, http://www.losrios.edu/lrc/ois/.
44. Atkinson and Mayo, *Refueling Innovation Economy*.
45. Robert D. Atkinson and Andrew S. McKay, *Digital Prosperity: Understanding the Economic Benefits of the Information Technology Revolution* (Washington, DC: ITIF, 2007), http://www.itif.org/files/digital_prosperity.pdf.

ACKNOWLEDGEMENTS

The authors wish to thank the following individuals for providing input to this report: Kathryn Angstadt, ITIF. Any errors or omissions are the authors' alone.

ABOUT THE AUTHORS

Dr. Robert Atkinson is the president of the Information Technology and Innovation Foundation. He is also the author of the books *Innovation Economics: The Race for Global Advantage* (Yale University Press, 2012) and *The Past and Future of America's Economy: Long Waves of Innovation that Power Cycles of Growth* (Edward Elgar, 2005). Dr. Atkinson received his Ph.D. in City and Regional Planning from the University of North Carolina at Chapel Hill in 1989.

Luke Stewart is an economic analyst at the Information Technology and Innovation Foundation. Prior to joining ITIF, he worked in business property appraisal, banking, and computer manufacturing. Luke earned a B.A. with highest honors in economics from the University of California, Berkeley, in 2009.

ABOUT ITIF

The Information Technology and Innovation Foundation (ITIF) is a Washington, D.C.-based think tank at the cutting edge of designing innovation strategies and technology policies to create economic opportunities and improve quality of life in the United States and around the world. Founded in 2006, ITIF is a 501(c) 3 nonprofit, non-partisan organization that documents the beneficial role technology plays in our lives and provides pragmatic ideas for improving technology-driven productivity, boosting competitiveness, and meeting today's global challenges through innovation.

FOR MORE INFORMATION, CONTACT ITIF BY PHONE AT 202.449.1351, BY EMAIL AT MAIL@ITIF.ORG, ONLINE AT WWW.ITIF.ORG, JOIN ITIF ON LINKEDIN OR FOLLOW ITIF ON TWITTER @ITIFDC AND ON FACEBOOK.COM/INNOVATIONPOLICY.