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A Policy Agenda for Offshoring

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The issues of globalization and the offshoring of high-skilled jobs are central to the recent innovation policy debate. Yet one major factor driving the process has been almost completely ignored. During the past two decades there has been a significant shift in the employment relations between U.S. employers and their American scientists and engineers. Corporate decisions are increasingly being made with little regard to how it affects workers. IBM, a leading employer, illustrates how radically these practices have changed over the past 20 years. As recently as 1992 IBM never laid off an employee, but since 2002 it adopted policies that force its U.S. workers to train foreign replacements as a condition of severance and unemployment insurance (Bulkeley 2004).

IBM isn't alone as these practices have become widespread in the American technology sector. An American software engineer (Engineer 2007) working at a major semiconductor company put it this way, "The basic plan where I worked was to hire H-1Bs [foreign workers in the United States on temporary work permits], train them, and use them as a way to outsource and transfer technology to China and India. I trained my replacement who was here on an H-1B visa from India." One reason this practice hasn't received more attention is that workers are afraid to discuss their cases. When I asked the software engineer if he would tell his story publicly, he demurred saying, "The company I worked for required [that] I sign a several page agreement stating I would not discuss company information. My human resources representative and manager both made it clear that the company has never lost any challenge and has gone out of its way to destroy the lives of the people who have caused issues. They tell everybody this, not just me. They would brag about cases." At the same time that this American engineer was training his foreign replacement, the CEO of his company was publicly complaining to Washington policy makers that there was a shortage of U.S. engineers.[1] This example reveals an important development—the welfare of corporate executives is no longer connected to their American workers.

The breakdown of employment relations has many important implications for innovation policy. Its impacts are amplified by other significant structural changes to the innovation system: the rise of the globally integrated enterprise; the ability of low-cost countries to attract research and development (R&D) and innovation work; the internationalization of U.S. universities; and the rising uncertainty and risk in the U.S. science and engineering labor market. In this paper I describe these changes and offer a policy agenda in response.

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The rise of the globally integrated enterprise

U.S. corporate leaders are not hiding the fact that globalization has fundamentally changed how they now manage their technology human resources. For example, in response to the discussion on offshoring and U.S. competitiveness, Craig Barrett, then CEO of Intel Corporation said that his company can succeed without ever hiring another American (Friedman 2005). And in an article in *Foreign Affairs* magazine, IBM's CEO Sam Palmisano (2006) gave the eulogy for the multinational corporation (MNC), introducing us to the globally integrated enterprise (GIE). He renders obsolete the familiar narrative that these firms have told us: they only locate facilities in China and India to serve customers there. In the article he says, "Many parties to the globalization debate mistakenly project into the future a picture of corporations that is unchanged from that of today or yesterday….But businesses are changing in fundamental ways—structurally, operationally, culturally—in response to the imperatives of globalization and new technology." The MNC model, where firms replicated their organization for each country where they sold, is now giving way to the GIE model, where firms geographically separate their production from the markets in which they sell. These principles are being put into practice by IBM and its rivals. For instance, when discussing his firm's aggressive moves to shift its share of workers to low-cost countries, Ron Rittenmeyer, then CEO of EDS (recently acquired by HP), said he "is agnostic specifically about where" EDS locates its workers, choosing the place that reaps the best economic efficiency. By 2008, EDS had 43% of its workforce in low-cost countries, up from virtually zero in 2002 (Jackson 2008).

With such fundamental shifts in firm behavior one would expect it to be a central topic in the offshoring policy discussion, but it has been absent. That's not by accident. While taking advantage of offshoring for their firms, many business leaders have also played predominant roles in shaping U.S. policy. Barrett was co-chair of the committee that produced Rising Above the Gathering Storm and Palmisano the co-chair of the Council on Competitiveness' National Innovation Initiative.

Firms are significant actors in the innovation process, and changes in their behavior will impact the U.S. National Innovation System (NIS) as well as the distribution of its benefits and costs. For example, advanced tools and technologies created or purchased by firms, will likely diffuse much more rapidly across borders, diminishing one of domestic technology workers' primary advantages —preferred access to those tools. Also as GIE's rebalance their workforces we can expect larger shares of technology workers in low-cost countries, and possibly smaller absolute workforces in the United States.

Since technology workers not only create new knowledge they are also an important source of entrepreneurship and start-up firms, the workforce rebalance may reduce America's share of technology start-ups. These new arrangements will make innovations less geographically sticky, raising questions about how to make public investments in R&D pay off locally or even nationally. On the plus side for America, global firms will have access to knowledge created in low-cost countries, if they aren't creating it themselves, and be able to diffuse and exploit that new knowledge in their U.S. operations. In short, the geographic location of inputs and the flow of technology, knowledge, and people are sure to be significantly altered by these changes in firm behavior.

But the more important manifestation is the ways in which corporations influence the political and policy processes. As Ralph Gomory (2007) has pointed out the interests of corporations and countries are diverging. Corporate leaders, who are not compensated by how many U.S. workers they employ or the long-term health of the U.S. economy, will pursue their policy interests with vigor even if those policies harm their U.S. employees or are bad prescriptions for the economy. Simply put, what's good for the United States may not be good for IBM and vice versa. While this may seem obvious, the policy and political processes have not fully adjusted to this reality. And there are no organized countervailing interests, such as organizations representing U.S. workers, to balance the policy making process. Further, the institutions that could play a mediating role in the policy making process have failed to provide a neutral forum for the policy discussion.

Much of the problem stems from the fact U.S. science, technology, engineering, and mathematics (STEM) workers have woeful political representation, especially in the

case of information technology (IT) workers. Information technology is the largest STEM occupational group. IT workers have been on the frontline of offshoring—losing jobs, opportunities and wages—yet they have no formal organization representing their interests in policy debates. Very few of these workers are members of a professional society or a labor union, less than 3% by my rough calculations. They simply have no voice in the policy process. They contribute no funds to political campaigns, fund no think tank to produce policy studies favorable to their interests, and they have no public relations specialists influencing how the press frames the issues that affect their interests.

One might argue that the professional societies are filling, or could fill, the void but the reality is they are politically weak and getting weaker. Further, they are globalizing themselves, which is the primary reason IEEE-USA has pulled back on its public advocacy on offshoring and high-skill immigration. It does not want to offend potential new IEEE customers in India and China, two growth markets.

Labor unions have admirably filled the political void, to the extent they can, but are also facing significant challenges. Union membership declined to a mere 7.6% of the private sector workforce by 2008, and the participation rate was lower for STEM workers (Bureau of Labor Statistics 2009, Table 3). A number of efforts to organize IT workers by labor unions have been largely unsuccessful, in spite of a terrible job market after the dot com bust that should have provided fertile ground.

The absence of STEM worker representation has significant policy consequences. Not a single person representing the interests of U.S. science, engineering, or IT workers was a member of the Rising Above the Gathering Storm or National Innovation Initiative committees that led to the COMPETES Act. Given this make-up, it shouldn't be any surprise that not a single recommendation required sacrifice from companies or universities, placing the entire burden on taxpayers and workers. Instead of playing a mediating role, high prestige policy organizations like the National Academies and the Council on Competitiveness have exacerbated the political imbalance between workers and employers.

Low-cost countries attract R&D sites

While firms are globalizing, another new phenomenon is emerging, the ability of low-cost countries to attract R&D and innovation. We have very limited information about how much and what kinds of innovation and R&D is being performed in low-cost countries, and the indicators of India's and China's innovation and research capabilities offer a decidedly mixed picture. For example, in 2006 China was by far the leading exporter of advanced technology products to the United States, surpassing all of the European Union combined. On the other hand the number of triadic patents—those filed in Europe, the United States, and Japan—awarded to Chinese inventors in 2002 was a mere 177 versus more than 18,000 for American and more than 13,000 for Japanese inventors (NSF 2007, Table 15).

A mixed picture also emerges from India. On the one hand India's indigenous information technology services companies, like Infosys and Wipro, have become the market leaders in their sector, forcing U.S.-based competitors like IBM and HP to adopt their offshore outsourcing business model. But, in 2003, India only produced 779 engineering doctorates compared to the 5,265 produced in the United States (NSF 2007, Table 3).

The standard indicators in this area are backward looking and are often out of date by the time they are published. One way to gain a forward looking indicator of China and India's emerging capabilities is by analyzing R&D announcements by multinational firms.

Recent surveys of corporate R&D managers indicate that India and China have become much more attractive as destinations for future R&D investments. A survey by the U.N. Conference on Trade and Development of the top 300 worldwide R&D spenders found that China was the top destination for future R&D expansion, followed by the United States, India, Japan, the U.K., and Russia (United Nations Conference on Trade and Development 2005). A 2007 *Economist* magazine survey of 300 executives about R&D site selection found that India was the top choice, followed by the United States and China (Canada followed as a distant fourth) (Kenney 2007).

There is no comprehensive list of R&D investments by U.S. multinational corporations, and the firms aren't required to disclose geographic breakdowns of R&D activities in financial filings. Since the U.S. government has yet to collect this data in any level of detail, we must rely on publicly available data. We do know eight of the top 10 R&D spending companies have R&D facilities in China or India, (Microsoft, Pfizer, DaimlerChrysler, General Motors, Siemens, Matsushita Electric, IBM, and Johnson & Johnson) (Atkinson 2007). Based on public announcements we also know that many are increasing their innovation investments in India and China.

General Motors has a research presence in both India and China. In October 2007, General Motors announced it would build a wholly owned advanced research center in Shanghai to develop hybrid technology and other advanced designs. This facility would be in addition to its 1,300-employee research center in Shanghai, part of a joint venture with Shanghai Automotive Industry Corporation (Bradsher 2007). Pfizer, the number two R&D spender, is outsourcing drug development services to India with 44 new drugs undergoing clinical trials there (Unnikrishnan 2007). The company has approximately 200 employees at its Shanghai R&D center, supporting global clinical development. Microsoft has a large and expanding R&D presence in both India and China. Microsoft's India Development Center, its largest such center outside the United States, has grown more than 12-fold since 2003 to employ 1,500 (*Economic Times* 2007; Microsoft 2008c). The Microsoft China R&D Group also employs 1,500 and in May 2008, Microsoft broke ground on a new $280 million R&D campus in Beijing, and in November announced an additional $1 billion investment for R&D in China (Microsoft 2008a; 2008b; and Chien and Wei 2008). Intel has approximately 2,500 R&D workers in India and has invested approximately $1.7 billion in its Indian operations (Krishnadas 2008). Its Indian engineers designed the first all-India microprocessor, the Xeon 7400 microprocessor, which is used for high-end servers. Intel has been investing in startup companies in China, announcing a $500 million Intel Capital China Technology Fund II to be used for investments in wireless broadband, technology, media, telecommunications, and "clean tech." (Mutschler 2008)

While General Electric spends less than the others on R&D it nevertheless provides an interesting case of a company with the majority of its R&D personnel in low-cost countries. Jack Welch, former CEO of GE, was an early and significant evangelizer of offshoring. The firm has four research locations worldwide, in New York, Shanghai, Munich, and Bangalore. Bangalore's Jack Welch R&D Center employs 3,000 workers, more than the other three locations combined. In fiscal year 2008, 47% of GE's revenues came from the United States and 84% from outside of Asia (General Electric 2009). So, clearly those R&D personnel are creating products for the global and high-cost country markets.

Perhaps the most important effect of these investments will be felt on the downstream benefits accruing from public investments in R&D, which are often targeted at economic growth and job creation. The payoff from such investments is not the R&D jobs created by government spending or subsidies, but rather the expectation that the downstream spillover benefits, in the form of start-up firms and design and development and production facilities, will be geographically sticky. The fact that China and India are able to attract R&D is an indicator that they have improved their ability to attract the mid-skill technology jobs in the design, development, and production stages.

U.S. universities begin to internationalize

Companies aren't the only institutions to globalize. U.S. universities, fundamental to the U.S. NIS, are beginning to internationalize in new ways. While these institutions have traditionally attracted large numbers of foreign students, they are beginning to take their education to foreign students by building campuses and offering STEM degree programs in other countries. Some, like Cornell in its mission statement, already identify themselves as *transnational* universities.

Offshoring is giving high-quality foreign students new job opportunities in their home countries making it less desirable to come to the United States to study. Those opportunities are increasingly with U.S.-based MNCs, thus creating new markets for universities. As a result, prominent U.S. universities are expanding their global

footprints to tap a more geographically diffuse student pool, especially in India and China. While there are no definitive counts of foreign campuses and programs established by American universities, experts believe that more universities, particularly high-prestige ones, are venturing abroad. Cornell, which already operates a medical school in Qatar, sent its president to explore opportunities in India in 2007. And Cornell isn't alone—many other engineering-intensive colleges, such as Rice, Purdue, Georgia Tech, and Virginia Tech, have made similar exploratory visits (Selingo 2007). Various programs have already been initiated by major engineering colleges. Carnegie-Mellon offers its technology degrees in India in partnership with a small private college there. Students take most of the courses in India, because it is less expensive, and then they spend six months in Pittsburgh to complete the Carnegie-Mellon degree (Sengupta 2007).

At the same time, to make their U.S. students more desirable in the job market, engineering colleges are providing more international experience for them through study abroad programs and other means.

University internationalization is still in its early stages and is still small in scale, but reports indicate that high-prestige U.S. universities have serious plans in the works to ramp up their overseas operations. Training U.S. students to be global may make them more competitive, but it may also accelerate offshoring, as they are better able to coordinate tasks spread out across countries. By creating campuses abroad, U.S. universities will change the patterns of flow of foreign students. It also creates more competition for U.S. STEM students who could have one of their key competitive advantages diminished.

There has been little discussion about how to harness the internationalization of U.S. universities for the U.S. national interest. The process appears to be inevitable so we should begin to identify the likely impacts and best practices.

Uncertainty and risk for U.S. STEM workers and students

The emerging opportunities for GIEs to take advantage of high-skilled talent in low-cost countries have markedly increased both career uncertainty and risk for the U.S. STEM workforce. Many U.S. STEM workers worry about offshoring's impact on their career prospects and are altering career selection. For instance, enrollments in bachelors programs in computer science dropped 50% from 2002 to 2007. Rising risks for job loss in information technology, caused in part by offshoring, were a major factor in students shying away from computer science degrees (Zweben 2008).

Offshoring concerns have been mostly concentrated on IT occupations, but many other STEM occupations may be at risk. Blinder (2007) estimated that nearly all (35 of 39) STEM occupations are offshorable, many of which he describes as "highly vulnerable." By vulnerable, he is not claiming that all, or even a large share, of jobs in those occupations will actually be lost overseas. Instead, he believes that those occupations will face significant new wage competition from low-cost countries, and there is no correlation between vulnerability and education level.

Workers need to know which jobs will be geographically sticky and which are likely to be offshored so they can make better choices for investing in their skills. But there is a great deal of uncertainty about how globalization will affect the level and mix of domestic STEM labor demand. The response of some workers appears to be to play it safe and opt for occupations that are likely to stay. In addition to the uncertainty introduced by offshoring, employment opportunities for some STEM occupations have become much more volatile heightening risk (Hira 2003).

For incumbent workers, especially mid-career ones, labor market volatility creates a special dilemma. The prior two technology recessions, from 1991-2 and 2002-4, have been especially long, longer than even for the general labor force. At the same time technology obsolescence cycles are shortening, so while unemployed, STEM workers are more likely to lose their skills faster than other professionals. If those unemployment spells are especially long it will be even more difficult to re-enter the STEM workforce when the market rebounds. An enormous amount of human capital is wasted when experienced STEM professionals are forced to move into other professions because of market vagaries.

Policy has been largely absent in trying to reduce risks and uncertainty for STEM workers. The government does not collect data on work that is moving offshore or real-time views of the STEM labor markets, both of which would help to reduce uncertainty. And Trade Adjustment

Assistance (TAA), the primary safety net for workers who lose their jobs due to international trade, has not—until passage of the American Recovery and Reinvestment Act—been available for services industries, where a large share of the STEM workforce is employed.

U.S. response to competition from the Indian IT services industry

The science and technology policy community is often focused on formal R&D indicators, institutions and policy levers, and as a result ignores important sectors that employ large numbers of STEM workers.

One of the most important high-technology stories of the past decade has been the remarkably swift rise of the Indian IT services industry, including firms like Wipro, Infosys, TCS, and Satyam, as well as U.S.-based firms like Cognizant and iGate using the same business model. There is no need to speculate about whether the Indian firms will eventually take the lead in the sector sometime in the future: they already have become market leaders. By introducing an innovative, disruptive, operational business model, the Indian firms have turned the whole industry upside down in the matter of four short years. It caught the U.S. IT services firms like IBM, EDS, CSC, and ACS flat-footed. Not a single one of those firms would have considered Infosys, Wipro, or TCS as direct competitors as recently as 2003 but now are chasing them by moving as fast as possible to adopt the Indian business model, moving as much work to low-cost countries as possible. The speed and size of the shift is breathtaking.

The important lesson is how those firms have responded to the competitive challenge. Instead of investing in their U.S. workers, with better tools and technologies, the firms chose to substitute low-cost country workers for U.S. ones.

IBM held a historic meeting with Wall Street analysts in Bangalore in June 2006, where the whole IBM executive team pitched their strategy to adopt the Indian offshore outsourcing business model including an additional $6 billion investment to expand its Indian operations (Rai 2006). IBM's headcount in India has grown from 6,000 in 2003 to 73,000 in 2007, and is projected to be 110,000 by 2010. This compares to a headcount in the United States of about 120,000 (Lakshman 2007). And IBM is not alone. Accenture passed a historic milestone in August 2007, when its Indian headcount of 35,000 surpassed any of its other country headcounts, including the United States, where it had 30,000 workers (Shah 2007). In a 2008 interview, EDS's Rittenmeyer extolled the profitability of shifting tens-of-thousands of the company's workers from the United States to low-cost countries like India. He said outsourcing is "not just a passing fancy. It is a pretty major change that is going to continue. If you can find high-quality talent at a third of the price, it's not too hard to see why you'd do this" (Jackson 2008). ACS, another IT services firm, recently told Wall Street analysts that it plans its largest increase in offshoring for 2009, when nearly 35% of its workforce will be in low-cost countries, moving more complex and higher wage jobs overseas (Thibodeau 2008).

Many other sectors could be offshored just like IT services, and in the advent of the GIE strategy it would be no surprise if the response by U.S. companies is similar.

What we should do

Most of the responses to offshoring will occur in the private sector, by firms and individuals, but governments can and should play a more significant role in ensuring that globalization works for the national interest. Given the speed by which offshoring is increasing in scale, scope and moving up the skill ladder, a number of immediate steps should be taken.

A. Establish a dedicated, stand-alone federally funded research and development center (FFRDC) to study the globalization of innovation.

Princeton's Alan Blinder has likened the economic transformation caused by offshoring to be equivalent on scale to the industrial revolution. The stakes are simply too large for the country not to invest in a better understanding of the economic impacts and policy implications of offshoring. Existing institutions cannot provide objective and unconflicted advice and analysis. The scale of the problem, and its growth rate, require a budget of at least $40 million per year for a new FFRDC dedicated to studying offshoring. Its agenda would be far ranging—from advis-

ing the agencies on data collection to generating policy alternatives for creating geographically sticky jobs.

The FFRDC should be created in a new organization, rather than an existing contractor to ensure that its functions and mission are focused and its resources are not poached by the parent organization. The FFRDC would conduct intramural and fund extramural research. The FFRDC should also be restricted from raising external funds to ensure that its work is not biased by external organizations.

Many academics, especially those in business schools, have set up research agendas studying ways that make offshoring more efficient and effective, essentially speeding up the offshoring trend. This is understandable given the operating model of most universities. Faculty respond to incentives and to date there have been no incentives to study offshoring from a U.S. national interest perspective. The government is the only institution that can fill this breach.

B. Creating the environment for worker representation in the policy process.

Imagine if a major trade association, such as the Semiconductor Industry Association, were excluded from having any representatives on a federal advisory committee making recommendations on trade and export control policy in the semiconductor industry. It would be unfathomable. But we have precisely this arrangement when it comes to making policies that directly affect the STEM workforce.

1. Government advisory boards, such as the National Science Board, should have members that represent the interests of American STEM workers.

2. Organizations that fall under the Federal Advisory Committee Act (FACA) rules should ensure that STEM workers are represented on committees making policy recommendations that affect STEM workers.

C. Collecting additional, better, and timelier data.

There is a consensus that poor data has severely limited analysis of, and policy as well as private responses to, the globalization of innovation and R&D. To remedy this situation, the National Science Foundation should work with the appropriate agencies (Bureau of Economic Analysis (BEA), Bureau of Labor Statistics (BLS), and the Census Bureau) to begin collecting additional and timelier data on the globalization of innovation and R&D. The broad-based effort should include a number of new initiatives.

1. The NSF Statistical Research Service (SRS) should augment existing data on multinational R&D investments to include detailed STEM workforce data. These data should track the STEM workforce for multinational companies in the United States versus other countries. Details should include occupation, level of education, and experience. These data should be reported on an annual basis and in a timely manner such that the data are from the most recent fiscal year reported by the companies.

2. The NSF SRS should collect detailed information on how much and what types of R&D and innovation activities are being done overseas.

3. The NSF Social, Behavioral, and Economic Sciences (SBE) division should begin a research program identifying the characteristics of jobs that make them more or less vulnerable to offshoring. The program should include a study estimating the numbers of jobs that have been lost to offshoring.

4. The NSF should make an assessment of the extent of U.S. university globalization. It should then track trends in university globalization.

5. NSF SBE should identify the impacts of university globalization on the U.S. STEM workforce and students. NSF SBE should begin a research program identifying and disseminating best practices in university globalization.

6. The NSF should conduct a study to identify the amount and types of U.S. government procurement that are being offshored.

7. The BEA should implement recommendations from prior studies, such as the 2006 study by MIT's

Industrial Performance Center, to improve its collection of services data, and especially trade in services data.

D. Creating better career paths for STEM workers.

STEM offshoring has created a pessimistic attitude about future career prospects for incumbent workers as well as students. New programs are needed to create better career paths for STEM workers including improved continuing education, a sturdier safety net for displaced workers, improving labor market signals and career information, expanding the pool of potential STEM workers by better utilizing workers without a college degree, and improving rates of successful re-entry into the STEM labor market after voluntary and involuntary absences. No American STEM worker should be forced to train his foreign replacement because of government designed loopholes in immigration policy.

1. The government should encourage the adoption and use of low-cost asynchronous on-line education targeted at incumbent STEM workers. The program would coordinate with the appropriate scientific and engineering professional societies. The pilot program should assess the current penetration rates of on-line education for STEM workers and identify barriers to widespread adoption.

2. Using H-1B fees, the U.S. Department of Labor should work with the appropriate scientific and engineering professional societies to create a pilot program for continuous education of STEM workers and to re-train displaced mid-career STEM workers. Unlike prior training programs, these should be targeted at jobs that require at least a bachelor's degree.

3. The NSF SRS should issue a report on improving the dissemination of STEM labor market signals, and begin reporting these data on a monthly basis. The report should assess the current state of labor market signals, and ways in which they may be distorted. The focus of the report is how workers and students receive information on the current and future prospects for specific STEM careers. The report should identify the appropriate data from the Department of Labor including data series such as Job Openings and Labor Turnover Survey (JOLTS), Displaced Worker Survey (DWS), and Business Employment Dynamics (BED).

4. The National Academies should form a study panel to identify on-ramps to STEM careers for students who do not go to college. This study should identify how many workers enter STEM careers without formal college degrees. And it should identify the barriers for additional workers, without college, to enter STEM careers and ways to overcome those barriers.

5. The National Academies should identify effective strategies for STEM workers to more easily re-enter the STEM workforce. STEM workers are more likely to leave the workforce, voluntarily and involuntarily, for extended periods of time.

6. Fix the broken high-skill immigration system by encouraging the best and brightest from abroad to stay permanently and reducing our reliance on guestworkers. First, fix permanent residency pathways by increasing the overall quota for high-skill permanent residents. We should move toward a two-channel approach in permanent residence, with a new merit point quota system coupled with a reduced reliance on employer-based sponsorship. Second, the loopholes in the H-1B and L-1 visa guestworker programs should be closed (the L-1 visa program allows companies to transfer certain classes of employee from their foreign operations to the U.S. operations for up to seven years). These loopholes enable employers to pay below-market wages and exploit vulnerable guestworkers, harming American and foreign workers alike. These H-1B and L-1 reforms should ensure that employers look for American workers first, pay market wages, and not displace American workers.

E. Improve the competitiveness of the next generation of STEM workers.

As universities globalize and multinational firms take the latest tools and technologies to STEM workers in low-cost countries, American STEM workers must find new ways

to compete. They can compete by finding new opportunities and niches in the types of jobs and tasks that will remain geographically sticky to the United States. Those opportunities and niches for American STEM workers need to be identified. Entrepreneurship and innovation training have been identified as sources of comparative advantage for American STEM workers that have yet to be fully exploited.

1. The National Academies should form a study panel to identify the types of curriculum reform that are needed, if any, in response to globalization. The aim is to ensure that U.S. STEM students graduate with the best skills to compete in the world.

2. The National Academies should form a study panel to examine best practices in teaching innovation, creativity, and entrepreneurship specifically target to STEM students.

3. The National Science Foundation should encourage study abroad programs for STEM students to improve their ability to work in global teams.

F. Public procurement should favor American workers.

Government procurement has been one of the primary areas of outsourcing policy debate, since about 40 states have legislation either pending or passed that restricts offshore outsourcing to some degree. Tennessee was the first state to pass this kind of legislation, but it is likely to pass in many more states. An outright ban does not make sense, but instead we should take a pragmatic approach to what should and should not be outsourced overseas. A simple one-size-fits-all approach just does not work.

American taxpayers have a right to know that government expenditures at any level are being used appropriately to boost innovation and help U.S. workers. The public sector—federal, state, and local government—is 19% of the economy and is an important mechanism that should be used by policy makers. There is a long, strong, and positive link between government procurement and technological innovation. The federal government funded not only most of the early research in computers and the Internet, but also was a major customer for those technological revolutions. Also, our billions in defense expenditures have helped to fund technological innovations, such as the Internet, that have commercial applications.

The first step is to do an accounting of the extent of public procurement that is being offshored. Then the government should modify regulations to favor STEM intensive work staying in America.

G. Establish tax and trade policies that put the United States on equal footing in attracting high-wage STEM jobs.

U.S. tax and trade policies currently discourage investments by companies in high-wage STEM jobs. Changes should be made to tax and trade policies to improve America's ability to recruit and retain R&D and innovation facilities.

1. Investigate "unfair" trade practices such as linking market access to a country with technology transfer, undervalued currencies, and theft of intellectual property.

2. Fix the perverse loopholes that provide firms a tax advantage for keeping profits overseas.

3. Explore more fundamental tax reform where corporate tax rates are scaled by the kinds of jobs they have in the United States. It would offer lower rates for companies with high-wage jobs and higher rates for low-wage jobs.

Conclusion

The science and technology policy community still has not taken the consequences of offshoring seriously. The issues of globalization and offshoring do not fall neatly along political party lines. Instead they are divided between elite and populist opinion, with elites seeing nothing wrong with it. Since the science and technology policy community is aligned with, and controlled by, elite opinion the policies they have promoted so far do nothing to fix the underlying problems facing STEM workers. It's time to change that.

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Endnotes

1. To keep the worker's identity anonymous, the company's name is withheld.