Six-Month Assessment of Workforce Globalization In Certain Knowledge-Based Industries

Technology Administration
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The Conference Report accompanying the Consolidated Appropriations Act of 2004 (P.L. 108-199) tasked the Department of Commerce's Technology Administration to conduct a six-month "assessment of the extent and implications of workforce globalization in knowledge-based industries such as life sciences, information technology, semiconductors and financial services." Three industries, representative of the United States' innovative and competitive strengths, were selected for analysis: the information technology (IT) services and software industry, the semiconductor industry, and the pharmaceutical industry.

The Conference Report also stated that the assessment should "focus on U.S. firms' business strategies and practices, as well as the education and training programs in countries such as Japan, China, and India." To support this, the review examined related business strategies and practices of U.S. companies within the three industries, and the education and training approaches of select nations in developing scientific and technical workers.

Methodology: This six-month review uses data available through June 2004. Currently collected government data can offer only very limited insight into the extent and impact of workforce globalization. Absent this ability to perform detailed empirical estimation, this review summarizes information gathered from a variety of sources in order to provide a snapshot of current trends in workforce globalization. Information sources for the analyses include: industry surveys; annual reports; Securities and Exchange Commission lOK and 20-F filings; government data on employment, direct investment, and trade; and published articles and reports. Additional qualitative information on U.S. firms' workforce-related practices and strategies was collected through discussions with companies, workshops with academia and industry experts, and attendance at industry conferences. The findings in this review are derived from working papers generated for the three industries and an additional working paper on education and training.

One challenge for this review was the ability to quantify the extent of workforce globalization within each industry. For example, it was not possible to accurately determine the actual number of workers or jobs moving from one country to another based on available employment, trade, and industry data. It was also not possible to determine whether the shift of U.S. work to non-U.S. locations resulted in job losses for U.S. workers or whether the shift of work to non-U.S. destinations was replaced by new work in the United States. Additionally while "insourcing" of work into the United States does occur and is seen by some as a vital part of workforce globalization, accounting for 6.3 million Americans employed by U.S. affiliates of foreign-owned companies with an annual payroll of $350

billion in 2001, this review focuses on outsourcing and offshoring and its impacts in the three knowledge-based industries.

It should be noted there are many recent studies showing that the globalization of the workforce, along with global sourcing, offers just as many opportunities as challenges for U.S. firms and workers. For example, according to the McKinsey Global Institute, if half of the potential transferable jobs in the United States were relocated, it would amount to a job turnover of 225,000 or approximately 1-2% of the jobs created in the United States each year. The McKinsey report highlights the following opportunities for US. firms and workers:

- The United States provides an environment to breed middle managers and high-end professionals, something other countries lack. The globalization of the workforce actually offers many opportunities for U.S. firms and workers.
- On a host of non-cost dimensions, including vendor location, market size, infrastructure, and environment, the United States remains an attractive place for other countries. In fact, the United States has a large and growing trade surplus in services (see chart below).
- Data on US. multinationals suggest that for; every one job that US. multinationals created abroad in their affiliates over 1991 to 2001, they created nearly two US. jobs at home.

Trade Surplus in Services

Additionally, according to the U.S. Bureau of Economic Analysis, for the past 25 years, three-fourths of the production, expenditures, and employment of U.S. multinational companies has consistently remained on American soil. From 1991 and 2001, for 2,500 multinational companies, employment in foreign affiliates rose by 2.8 million jobs and employment in U.S. parent firms rose even more-by some 5.5 million jobs.

Background: Many businesses today regard global operations as a way to access new markets, sources of revenue, technologies, and alternative production configurations. As companies globalize business operations, effects on work and workers follow. U.S. companies in the three knowledge-based industries that were surveyed in this assessment generally indicated that they operate worldwide to reduce costs, locate closer to their global customers and to meet the round-the-clock expectations for customer service delivery.

Knowledge-Based Industry: "Knowledge-based" industries are those characterized by an emphasis on creating value from new ideas and concepts, as distinct from material inputs and demanding physical labor. For example, the products of the software industry are among the most conceptual and intangible of all new products. Today, knowledge-based work can be seen in areas including software development, financial services, pharmaceuticals, engineering services, biotechnology, and semiconductors among others.

This shift in emphasis from physical materials to ideas as the core of value creation has accelerated in recent decades and is at the center of a knowledge-based industry. This shift is also reflected by what workers do on the job, with a growing proportion of the U.S. workforce creating value through intellectual endeavors, rather than predominately through manual labor. Finally, knowledge-based industries are also characterized by the education and skill of their workers. These industries have a significant portion of their workforces in non-routine jobs, in which workers create, interpret, analyze, and transform information to create economic value from knowledge.

Workforce Globalization: For decades, industries have become international through several means: in the manufacturing supply chain, in the movement of goods across borders through trade, in the movement of capital, and in the flow of technology and intellectual property. Workforce globalization occurs in a variety of ways and various terms have been used to describe these shifts of work. This review used the definitions below for three commonly used terms: outsourcing, offshoring, and insourcing. It should be noted, however, that workforce globalization also can arise in other ways. For example, a U.S.-based multinational company might expand its operations, offer related services in locations outside of the United States, or enlarge its existing product line to meet differing demands by foreign consumers. These new or expanded activities may reflect jobs created abroad that do not directly displace current U.S. workers, although some may view these as jobs that could have been performed by U.S. workers and once might have been expected to be performed in the

5 Based on surveys conducted by Technology Administration analysts collected through private discussions with companies, workshops with academia and industry experts, and attendance at industry conferences.

United States. As a result of the potential implications for U.S. job creation and employment, these manifestations of workforce globalization have often been lumped together in offshoring discussions.

- Outsourcing is when a company relocates a whole process, a piece of a process, a function, or a discrete piece of work outside of its own corporate boundaries. Companies seeking to focus their management, workforce, capital, and other resources on their "core competencies" examine their business processes for work that can be performed effectively and cost-advantageously outside the company--such as accounting, human resources management, call centers, or information technology operations-while preserving the company's competitive strengths and maximizing financial gain.

- Offshoring refers to the relocation of a whole process, a piece of a process, a function, or a discrete piece of work outside the geographic boundaries of the United States. The work can be done in an offshore location either within the boundaries of the company or outside the boundaries of the company.

- Insourcing describes work offshored by other nations into the United States. Insourcing is the movement of foreign jobs to the United States and has risen in recent years as more foreign firms set up operations in America with new foreign direct investment in the U.S. totaling $39.9 billion in 2003, U.S. subsidiaries reinvesting $38.6 billion in their U.S. operations, and U.S. subsidiaries spending $27.5 billion on U.S. research and development activities6

General findings from this review's analyses suggest that:

The U.S. business climate, large consumer markets, and a formidable research and university system remain magnets for business activity and continue to attract leading scientific and technical talent to these knowledge-based industries.

U.S. companies in the knowledge-based industries that were surveyed use workforces in other countries for a variety of reasons: market expansion, increased focus on core competencies, service of customers in other nations, and, in some cases, cost savings. Access to labor pools in other countries allows

U.S. companies to scale their workforces in response to constantly changing business requirements. The U.S. companies that were surveyed generally tap labor pools in other countries for specific segments of their operations, rather than the entire value chain of work.

- U.S. companies in the knowledge-based industries that were surveyed are dividing business processes into smaller discrete elements-rather than the traditional divisions of research, production, and marketing-allowing them to outsource pieces within a larger business process. This can occur through geography, as a result of dispersed centers; in particular components of a work process, such as semiconductor design or customization of a standard IT application; in work sharing, 24-hour operations with teams around the world; or through arrangements where companies work with affiliates in other locations.

- While India and China are attempting to develop national science and technology education systems that meet international standards, they face obstacles in creating such systems. Mass post-secondary enrollments in both countries reflect a movement from education of the elite to more universal access which means that existing educational infrastructure will have to be improved. The quality of the curricula and training, and whether they are equivalent to U.S. degrees, has not been well-assessed.

- New approaches to data collection could enable a better understanding of the effects of workforce globalization on an industry, worker displacement, national productivity, and economic growth. The Commerce Department's Bureau of Economic Analysis and the Labor Department's Bureau of Labor Statistics are seeking to create better, quantifiable measures to understand these trends.

The following sections summarize key findings from a review of the workforce and economic trends in the three industries. Also included, are findings from a review of the education and training systems in China and India.

Information Technology (IT) Services and Software

In the global competition for IT services and software work, the United States has capabilities and strengths that make it a choice location for work with certain characteristics. IT services and software firms have work performed where they believe it will be done most effectively and cost-efficiently.

Offshoring, currently represents less 3% of total U.S. IT services and software spending. The lack of detailed domestic and international data on workforce, industry, and trade prevents a strong quantitative assessment of the full extent of global sourcing of IT services and software work, and an assessment of longitudinal trends.

While the U.S. IT industry has experienced a decline in job growth since the boom of the 1990's tech bubble, it is not clear what impact offshoring has had on the industry. The acceleration in offshoring coincided with a variety of other factors that affected IT employment significantly, including the bursting of the Internet dot.com "bubble;" a downturn in the business cycle; the end ofY2K preparations; and the terrorist attacks of September 11, 2001.

Businesses recognize that there are a number of risks, however, associated with offshoring IT services and software that could deter U.S. companies from moving certain operations overseas. These risks include vendor/contractor management challenges; cultural and communication barriers; data security and confidentiality; difficulty in effective knowledge transfer; time zone differences; inadequate telecommunications and other infrastructure; unexpected costs; risk to intellectual property; exposure/loss of core business knowledge; lack of offshoring management skills; geopolitical instability of a destination nation; political backlash and adverse publicity; foreign government impediments; and different work schedules.

Businesses want to retain certain kinds of IT services and software work in the United States. Characteristics of such IT work include: products or processes in which there is uncertainty about customer needs or specifications; projects requiring highly iterative development processes; work that involves a high degree of personal interaction with end-users or clients; work that crosses many disciplines; applications with complex procedures, such as, substantial manual intervention and data fixes; applications that involve a high degree of integration with other systems developed and maintained on-shore; work involving nuances or deep cultural understanding; work in which much of the knowledge exists only in the minds of the on-shore IT staff; analytical tasks, leading-edge research, and non-rule-based decision-making; high levels of creativity, innovation, insight, "thinking outside the box"; high management interaction requirements; process design and business analysis; technology and systems integration (applications, hardware, and networks); and fusion of industry knowledge, high-level IT skills, and business process expertise.

9 See "Impact of Offshore IT Software and Services Outsourcing on the. U.S. Economy and the IT Industry," Information Technology Association of America and Global Insight, March 2004.
10 Based on industry surveys conducted by Technology Administration analysts collected through private discussions with companies, workshops with academia and industry experts, and attendance at industry conferences.
II Ibid.

The semiconductor industry in the United States operates in a dynamic economy, capital market, and business environment that allow entrepreneurs to take new ideas to market quickly.

- The U.S. semiconductor industry is considered to have a creative design sector. For example, the United States has the only "fabless" company, which focuses exclusively on design and development without silicon wafer fabrication and manufacturing, in the top 20 semiconductor companies worldwide.
- U.S. semiconductor companies work with leading research universities in cutting-edge research, developing new technologies, and in training talent.
- The industry can draw on a large educated, skilled, and experienced workforce. within the United States. Even though some workers in lower wage countries can match U.S. workers in technical skills and education, they lag behind U.S. workers in experience and management skills.
- The U.S. semiconductor industry maintains a historical advantage in intellectual property and dominates the lucrative microprocessor market.
- Despite past challenges from Japanese and Korean competitors, the U.S. semiconductor industry remains the leader in world market share.

U.S. companies have the leading share of global semiconductor revenues. Highly skilled workers within the U.S. semiconductor industry--including engineers in manufacturing, design, and R&D--remain mostly in the United States. In 2003, 70% of the U.S. semiconductor industry's engineers worked in the United States and 75% of the industry's labor compensation remained in the United States. The majority of the industry's R&D, design, and cutting-edge manufacturing remain in the United States.

The U.S. semiconductor industry is global in scope and scale. The industry has long maintained sales and marketing operations around the world, semiconductor design centers in proximity to overseas customers, and some R&D in the European Union (EU), Israel, and other areas. The industry has also offshored assembly, testing, and wafer fabrication to locations around the world.

Countries with educated, skilled, and available engineering workforces have made development of a domestic semiconductor industry an integral part of their growth model. Foreign nationals educated and trained abroad have become an important resource for their countries - particularly in India and China - because they can provide the mentoring, management, and on-the-job training workers in those countries need to become high value-added employees. Many also manage foreign affiliates for U.S. multinationals.

- A recent survey in *Asia's Educational Edge* (2001) indicates that about 57% of Chinese graduates of U.S. universities plan to return home within 10 years.

12 Semiconductor Industry Association, Industry Facts & Figures, 2004. 13 Semiconductor Industry Association, Industry Facts & Figures, 2004.

- Government planning and incentives in China and Taiwan have resulted in large investments in wafer fabrication plants. Excluding Japan, Asia is projected to build 74% of the world's new semiconductor manufacturing capacity compared to North America's 8% in the next few years.
- China is seen as having the critical mass of educated engineers, available capital, and business' incentives to foster a strong domestic semiconductor industry; it is the world's fastest growing semiconductor customer, having invested more than any other country in new semiconductor manufacturing facilities and has momentum to attract talent.

The U.S. semiconductor industry retains unique strength and will remain a growth opportunity globally.

- The U.S. semiconductor industry operates in a dynamic economy, capital market, and business friendly environment allowing entrepreneurs to bring new ideas and companies to market quickly and exploit new structures and niches in the industry. The United States has top-notch research universities and university-industry-government lab interaction with the ability to invest in cutting-edge technologies that can transform industry processes and cultivate top talent. The United States has a large educated, skilled, and experienced workforce. Even though workers in some lower-wage countries can match U.S. workers in technical skills and sometimes education, they lag behind U.S. workers in experience and management skills.

- The U.S. semiconductor industry is very diverse, competing in every part of the value chain. It has a particularly creative design sector, with around 500 fabless companies.

  The U.S. semiconductor industry maintains an historical advantage in intellectual property and dominates the lucrative microprocessor market. It has survived previous competitive challenges from Japanese and Korean industries, and prospered and regained leading world market share. Even though many U.S. companies are becoming fab-lite or fabless, it appears that the United States will maintain a core of cutting-edge manufacturing and process R&D in some of its larger semiconductor companies.

Pharmaceuticals

The United States is widely recognized as the current global center for pharmaceutical research and innovation. This reflects a confluence of favorable circumstances in recent years for industry innovation, as well as the result of deliberate U.S. policies and initiatives.

14 Semiconductor Industry Association, Industry Statistics, 2004.

- These factors include abundant support for pre-competitive research (most notably basic research at the National Institutes of Health); a continuing stream of U.S. scientific achievements; a strong pool of world-class scientific talent; strong business and capital market support for aggressive development and commercialization of potential new therapeutic drugs; an attractive U.S. marketplace that is the world's largest; and a transparent and science-based government regulatory regime for approving the market entry of new pharmaceuticals.

The pharmaceuticals industry is considerably global in scope and scale.

- The top ten companies in the pharmaceuticals industry, of which five are headquartered in the United States, account for about 46% of global sales. These ten companies have production chains for research, development, manufacturing, marketing, and world-wide sales.
- The rest of the pharmaceuticals industry is composed of a large number of companies with varying product mixes, market geography, and production activities.
- The pharmaceuticals industry's largest and most successful companies perceive the markets for their products to exist beyond the shores on which they are headquartered. The pharmaceuticals industry's smaller companies also appear cognizant of global opportunities for product sales and sourcing of production activities.

While it has been a particularly successful sector of the U.S. economy for some time, the pharmaceuticals industry is a modest employer domestically. The industry directly employs about 294,000 workers in the United States.

- The pharmaceuticals industry's overall employment growth in the United States has averaged about 2.5% annually over the last five years. About 27% of these workers are engaged in scientific, professional, or technical activities.
- These employment figures do not account, however, for services provided by contract research organizations or for university and non-profit R&D organizations working in collaboration with pharmaceutical companies. These are important ancillary components of the pharmaceuticals innovation and production cycle, but their numbers are not well documented statistically.

Data currently available on pharmaceuticals industry jobs from government and industry sources do not enable a clear and comprehensive picture of the current employment share of the United States relative to the global industry or of the relevant employment growth trends.

Further consolidation of the industry globally, through mergers and acquisitions, is likely in the years ahead. Factors underlying this expected trend include:

- The pharmaceuticals industry's economic fundamentals, particularly the high cost and risk of research and product development, will relentlessly push management to search for reorganization opportunities, asset configurations, and investment portfolios with the promise of improved efficiencies and economies of scale and scope.
- Also, the increasingly global nature of the life sciences research enterprise will provide numerous opportunities for companies to incorporate creative new elements into their capabilities.

Pharmaceutical innovation will remain a growth opportunity globally for many years to come. The basic science frontier is likely to continue to advance at a fast pace (building on the recent progress in genomics and related molecular biology fields). This will open many new opportunities for pharmaceutical innovation.

With continued scientific strength and sufficient incentive for industry to take on and invest in the difficult and expensive task of new pharmaceutical development, the United States should retain its role as world leader in pharmaceutical innovation. There are, however, some challenges and issues that must be overcome:

- Capabilities for strong science and technology in the life sciences arena (human talent, resources, and infrastructure) are growing abroad. Many other countries (in Europe, Asia, and Latin America) indicate strong future aspirations in the biosciences, biotechnology, and associated industries and markets. Some of this interest reflects country desires to respond to domestic healthcare needs, some to interest in eventually competing with unique products in the global pharmaceuticals marketplace. Aggressive efforts are now underway in Europe, some parts of Asia, and elsewhere to plan, invest in, and develop a globally competitive life sciences industry.
- There are numerous scenarios regarding how these various factors may play out over the next 5-10 years. In most cases, the U.S. part of the global phannaceutical industry should remain on a path of significant business and employment growth-reflecting the comparative strength the U.S. industry currently enjoys relative to other players.

Education and Training in Other Countries

The United States has historically been a leader in higher education and training, but other countries are beginning to provide comparable quality and access to education. For example, in 2001, 30.4% of the 24 year-olds in Taiwan had bachelor's degrees, 26.8% in South Korea, as compared to about 33.8% in the United States.

Both China and India, with their large populations, have realized dramatic increases in the numbers of students entering secondary education, especially in science and engineering. These increases have allowed them to compete for tasks historically the purview of developed nations such as tasks in production, R&D, and services.

- While China and India have low overall enrollments as a percentage of their populations, they are closing the gap with the United States in terms of absolute number of degrees earned. Some 2.9 and 4.2 college students per hundred people in China and India, respectively, earned science and engineering degrees in 2001.
- In 2000, China awarded 337,000 science and engineering degrees compared to 398,622 for the United States, while estimates for science and engineering degrees awarded in India range from 392,000 (1997) to about 630,000 (2001). It should be noted, however, that according to the World Bank and the Federal Reserve I 5 just 18% of China's population presently aged 25-65 has a high school degree, compared with 84% in the United States. Just one 1 of20 Chinese in that group has a college degree, compared with almost 1 in 3 in the United States. China also imports education from the rest of the world. For example, in 2002, about 182,000 Chinese students were studying abroad.

Despite the movement to improve secondary education systems in science and engineering to international standards, both India and China face significant challenges.

- Challenges in India include increasing enrollments coupled with stagnant state expenditures; inadequate policy framework for private financing and philanthropy; minimal university research budgets; non-competitive faculty compensation packages; outdated facilities; and rigidly bureaucratic academic structures.
- The demand for IT professionals in India has spurred the growth of private training institutes providing short- and long-term training; however, the quality of instruction at these institutions varies widely.
- Challenges in China include massive expansion in enrollments coupled with drastic reforms to transform to "world class" standards; a science and technology base that is heavily dependent on the government's ability to attract foreign direct investment and outside expertise; and obsolete and poorly funded government research institutes.

With the promise of improved economic environments in their home countries, foreign nationals educated and employed in the United States are now attracted to returning to their home countries instead of remaining in the United States.

- China is making great efforts to bring back U.S-educated Chinese scientists and engineers to work on or start new businesses, and U.S. stay rates for Chinese graduates are beginning to decline. While NSF data indicated almost 95% of U.S. science and engineering doctoral degree recipients from China reported that they

15 World Development Indicators, World Bank; and"China's Economic Growth," Federal Reserve Bank of Dallas, June 14, 2005.

had plans to remain in the United States (1985-2000), a different survey in *Asia's Educational Edge* (2001) reported that 21 % had plans to go home within 5 years,
36% had plans to go home within 5-10 years, and 23% had plans to go home after 10 years.

The Taiwanese government has estimated that Taiwan will need an additional 10,000 engineers if the country is to realize its goal of becoming a larger center for the design and engineering of sophisticated products like semiconductors. The government is offering incentives such as tax breaks and direct subsidies to recruit multinational companies to set up R&D operations in Taiwan.

The Philippines has a relatively small base of IT workers, and its government is attempting to create a local base of IT work by stimulating the development of domestic IT companies.

The Irish government is also taking steps to ensure a steady supply of IT workers.
Ireland is a key IT offshoring destination and is the largest exporter of software in the world outside of the United States. Government plans include support for in-company training, inter-disciplinary learning at universities, recruitment of women and disadvantaged groups, and favorable immigration policies to attract foreign students.