A Report by a Panel of the

NATIONAL ACADEMY OF PUBLIC ADMINISTRATION

for the U.S. Congress and the Bureau of Economic Analysis

OFF-SHORING:
What Are Its Effects?

January 2007

NATIONAL ACADEMY OF PUBLIC ADMINISTRATION®

A Report of the Panel of the

NATIONAL ACADEMY OF

PUBLIC ADMINISTRATION

For the U.S. Congress and the Bureau of Economic Analysis

January 2007

OFF-SHORING:

WHAT ARE ITS EFFECTS?

Panel

Janet L. Norwood, *Panel Chair**
Carol Carson
Manuel Deese*
Norman J. Johnson*
Franklin S. Reeder*
John E. Rolph

** Academy Fellow*

Officers of the Academy

Valerie A. Lemmie, *Chair of the Board*
Jonathan D. Breul, *Vice Chair*
Howard M. Messner, *President*
J. Christopher Mihm, *Secretary*
Franklin S. Reeder, *Treasurer*

Project Staff

J. William Gadsby,* *Vice President, Academy Studies*
Terry F. Buss, PhD, *Program Area Director*
Kenneth F. Ryder Jr., *Project Director*
Harry G. Meyers, PhD, *Senior Advisor*
Gwyneth H. Caverly, *Senior Research Analyst*
Jennifer Blevins, *Senior Research Analyst*
Noel A. Popwell, *Senior Research Associate*
Martha S. Ditmeyer, *Senior Administrative Specialist*

National Academy of Public Administration
1100 New York Avenue, N.W.
Suite 1090 East
Washington, D.C. 20005
www.napawash.org

First published January 2007

Printed in the United States of America
ISBN 1-57744-123-0

Academy Project Number: 2051-000

* *Academy Fellow*

FOREWORD

Shifting business operations to off-shore locations and its impact on America's workforce and economy are central features in the policy debate over globalization. Especially important is the impact on the nation's high technology—services—industries, especially high-skilled workers.

Off-Shoring: What Are Its Effects? is the third of three Academy Panel reports providing a comprehensive review of services off-shoring. This report answers four critical questions that frame some of the debate about services off-shoring:

- What is the effect of services off-shoring on the science and engineering labor market?
- How do temporary high-skilled foreign workers affect services off-shoring?
- Are U.S. universities keeping pace with the demand for science and engineering workers? Are American students not choosing these careers?
- What are the effects of foreign direct investment on U.S. employment?

The House Appropriations Subcommittee on Commerce, Justice, Science and Related Agencies mandated this study in response to growing concerns about the loss of American jobs overseas. Congress asked the Academy to gather the facts about off-shoring and make recommendations to address issues raised.

I want to thank Panel Chair Janet Norwood for her leadership and the other Panel members, Carol Carson, Manuel Deese, Norman Johnson, Franklin Reeder and John Rolph, who contributed substantially to the project. I also commend the project staff for their sophisticated research and thoughtful analysis in support of the Panel's findings and recommendations. Finally, I would like to express my appreciation to Congress, especially former Chairman Frank Wolf, for supporting this research; the staff and management of the Bureau of Economic Analysis and Bureau of Labor Statistics without whose cooperation and support this project could not have been undertaken; and the dozens of researchers, experts, program managers and policy makers who shared their knowledge and insights.

We hope that the findings and recommendations in this study help shape the off-shoring debate.

Howard M. Messner
President

ACRONYMS

Academy	National Academy of Public Administration
BA	Bachelor of Arts
BEA	Bureau of Economic Analysis
BLS	Bureau of Labor Statistics
CIPSEA	Confidential Information Protection and Statistical Efficiency Act
CPST	Commission on Professionals in Science and Technology
DHS	Department of Homeland Security
DOS	Department of State
EIN	Employer Identification Number
EPO	European Patent Office
ETA	Employment and Training Administration
FDIUS	Foreign Direct Investment in the United States
FY	Fiscal Year
GAO	Government Accountability Office
GDP	Gross Domestic Product
ICT	Information and Communication Technology
INS	Immigration and Naturalization Service
JPO	Japanese Patent Office
MBA	Masters of Business Administration
MGI	McKinsey Global Institute
MNC	Multi-national Corporation
MOU	Memorandum of Understanding
NAICS	North American Industrial Classification System
NBER	National Bureau of Economic Research
NSF	National Science Foundation
OECD	Organization for Economic Cooperation and Development
OES	Occupational Employment Statistics
PCAST	President's Council of Advisors on Science and Technology
QCEW	Quarterly Census of Employment and Wages
R&D	Research and Development
RDT	Research, Development and Testing
S&E	Science and Engineering
SOC	Standard Occupation Classification
STEM	Scientific, Technical, Engineering and Mathematics
USDIA	United States Direct Investment Abroad
USPTO	United States Patent and Trademark Office
WIPO	World Intellectual Property Organization
Y2K	Year 2000

TABLE OF CONTENTS

CHARTS AND TABLES

Charts

Tables

EXECUTIVE SUMMARY

The services sector—especially the high-technology, science and engineering (S&E) sub-sector—has been a major source of U.S. innovation and technological advances that have fostered productivity improvements, economic growth and greater prosperity. This sector has been less susceptible to international competition and overseas migration, though that perception has been eroded by numerous anecdotes and advocate reporting on the prevalence of services off-shoring. In response, the House Appropriations Subcommittee on Science, State, Commerce and Justice[1] provided for a comprehensive study of off-shoring by the National Academy of Public Administration (Academy).

This third Academy Panel report on off-shoring—*Off-shoring: What Are Its Effects?*—examines the relationships among services off-shoring, economic globalization, the S&E labor market, role of temporary high-skilled foreign workers, American student career choices and the university system's production of new S&E workers. It also examines the economic effects of service "in-shoring," the obverse of off-shoring.

At the outset, we present the Panel's key findings on off-shoring and globalization.

OVERALL OBSERVATIONS

The Panel finds that services off-shoring has had little economic impact on the S&E labor market, education of S&E workers, or S&E career choices of American students. This may be partly attributable to the apparently limited extent of services off-shoring over the last five years,[2] but it also may reflect the submergence of off-shoring effects into the deeper and more widespread challenges imposed by economic globalization. High-skilled temporary foreign workers are critical in meeting the growing domestic demand for S&E labor and reducing need to off-shore high tech services.

The Panel believes that economic globalization—the emergence of individual national economies into a more highly integrated network—is likely to increase services off-shoring. This may result from *business restructuring* (where a business restructures its internal production processes and replaces domestic workers with imported inputs from a foreign supplier) or *global expansion* (where a business decides to expand its operations or production activities in foreign markets).[3] This is one challenge that globalization presents. A more critical challenge is the declining U.S. share of scientific knowledge and technical expertise as a greater number of diverse knowledge centers emerge in a global economy. The ability of the United States to respond and establish a new leadership role, especially by effectively leveraging new knowledge

[1] In January 2007, Congress renamed this the Appropriations Subcommittee on Commerce, Justice, Science, and Related Agencies.

[2] See National Academy of Public Administration, *Off-shoring: How Big Is It?*, October 2006, Highlights and Panel Message sections

[3] Ibid., see Chapter 2, p. 46-48, for more detailed description of these two distinctly different types of services off-shoring.

and transforming it into innovative and marketable products and services, will determine its prospects for continued future economic growth and development. How effectively the nation meets these challenges and exploits opportunities will determine the extent to which firms will off-shore services in the future.

The Panel suspects that services off-shoring may be more a manifestation of expanding economic globalization than a cause of it. In an expanding, more globally integrated economy, the role of multinational corporations (MNC) increases, trade liberalization supports an increase in trade and investment flows, new centers of scientific knowledge and engineering expertise develop in diverse areas, new supplies of high-skilled workers become available, and continued improvements in communications and other information technology enhance networking capabilities. Together, these accelerate economic integration and may increase U.S. businesses off-shoring, either through business restructuring or global expansion. Any subsequent increases in off-shoring add to the larger trade and investment flows that support globalization.

S&E LABOR MARKET, GLOBALIZATION AND SERVICES OFF-SHORING

For the S&E labor market, the Panel posed several questions: How well has the labor market met the need for high-skilled labor given the major challenges it has faced over the past several years? How has that market been affected by expanding economic globalization? What are the major challenges and opportunities for a more globalized labor market and what are the implications for future services off-shoring?

The Panel reviewed trends in employment growth, entry level salaries, unemployment rates and use of foreign S&E workers to assess how well the S&E labor market responded to the U.S. economy's increased demands for high-skilled S&E workers, severe economic shocks, the Y2K crisis, dot.com boom and bust and 2001 recession. If the market had periodic problems meeting increased demands for workers, U.S. business might have shifted some activity off-shore to access a larger pool of labor. Data showed that:

- The S&E share of the total workforce increased steadily from 2.6 percent in 1983 to 3.9 percent in 2004, with decreases in 1992 and 2002 resulting from the 1991 and 2001 recessions, respectively.

- From 1993 to 2003, median real salaries for recent graduates with S&E degrees in engineering, math, and computer science grew substantially faster than those for recent graduates with non-S&E degrees. Most of the growth for computer scientists occurred between 1993 and 1999.

- S&E unemployment rates were less than the aggregate unemployment rate from 1983 through 2004, except for computer programmers in 2001, 2002 and 2004. The differential between the rate for all workers and S&E workers appeared to narrow.

- Foreign-born college graduates in the U.S. S&E workforce increased from 11.2 percent in 1980 to 22.4 percent in 2000.

The S&E labor market appeared resilient in responding to numerous significant economic shocks and continued to meet the U.S. economy's growing demands for high-skilled labor. In short, there is little evidence that an insufficient supply of labor has forced American businesses to off-shore high-tech services to secure necessary skills.

A review of selected indicators of scientific knowledge and technical information (e.g., S&E journal article publications, article citations, and patent applications) showed that a number of foreign countries increased their rankings or scores on research and development indicators, while the U.S. declined over the last decade or two. America's once dominant position as a center of scientific knowledge and technological advances may not necessarily continue in an increasingly global S&E market.

The more intense global competition for S&E human capital presents another principal globalization challenge. As new centers of scientific knowledge and technical skills emerge, a more globally integrated market increases opportunities for additional off-shoring of high-tech services. Increases in foreign R&D spending supporting development of diverse knowledge centers also present opportunities for those who can effectively access and use this knowledge and skill. Leveraging and transforming that new knowledge into innovative and marketable products and services are critical, not only for establishing a new leadership role but also for continuing economic growth and prosperity.

The United States' success in establishing and maintaining a new leadership role in a more global S&E market directly depends on its ability to attract and retain high-skilled foreign S&E workers, as well as U.S. businesses' and workers' ability to adapt to changes from more and diverse sources and apply them in innovative ways to improve productivity and expand economic activity.

The Panel believes that U.S. universities should improve the quality and quantity of their S&E graduates to help them and their employers compete more effectively in a rapidly changing and more intensely competitive global market. Enhancing the adaptability and responsiveness of the domestic S&E workforce to a more turbulent labor market will require adjustment assistance, unemployment insurance, re-training and other worker support programs that effectively address emerging market challenges.

The Panel recommends that:

- **The President and Congress reduce legislative and administrative barriers to the flow of high-skilled S&E workers to the United States.**

- **The President and Congress reassess the effectiveness and applicability of current worker support programs relative to the challenges presented by the global economy.**

THE ROLE OF TEMPORARY, HIGH-SKILLED, FOREIGN WORKERS

With regard to temporary foreign workers, the Panel focused on the following questions: How have temporary foreign workers contributed to the S&E labor market? Who are the primary beneficiaries of temporary workers? What impact do temporary workers have on off-shoring and globalization?

To assess the effect of high-skilled foreign S&E workers entering the United States under the temporary H-1B and L-1 visa programs, it is necessary to identify how many actually work in the United States, who they are, where they come from, what jobs they take, how long they remain, and what happens to them when their temporary visas expire. Unfortunately, current Department of Homeland Security (DHS) data limitations—both data bases are administrative, workload oriented and not designed for analytical use—precluded identifying the number of these temporary workers actually employed in the United States. This, in turn, prevented any assessment of the share of total U.S. S&E workers accounted for by temporary H-1B and L-1 visa holders, in the aggregate and for specific occupations and S&E disciplines. Nonetheless, available administrative data suggest that:

- H-1B and L-1 visa programs have increased the supply of high-skilled workers to help meet increasing domestic demands for S&E labor. As such, they likely reduced the need to off-shore high tech services.

- The primary beneficiaries of H-1B and L-1 visa programs are workers from India and China, but many other countries participate as well. Most of these workers are younger than the domestic S&E workforce. Contrary to popular belief, most do not hold PhDs or even graduate degrees. A substantial majority of those obtaining an H-1B visa in any year are already in the United States, as a foreign student, temporary worker seeking to extend their current visa, visitor or some other status.

- Beneficiaries are not primarily computer programmers, but work in a variety of computer-related fields as the visa programs intended.

The Panel believes that the H-1B program provides a useful means of retaining high-skilled foreign S&E workers trained in the United States, at least temporarily. This provides businesses a viable alternative to shifting high tech services off-shore to secure similar critical skills.

Because high-skilled workers on temporary work visas meet increasing domestic demand for S&E workers, and help graduating foreign students obtain work in the United States if they seek it, the Panel recommends that:

- **The President and Congress remove barriers to accepting high-skilled work in the United States and remaining here to continue that work.**

- **The Department of Homeland Security improve its data systems to provide a more accurate accounting of the number of H-1B and L-1 temporary foreign**

workers actually employed in the United States and address other unanswered key questions about them.

OFF-SHORING, GLOBALIZATION AND S&E HIGHER EDUCATION

Concerning higher education, the Panel focused on the following: Is America's higher education system meeting the needs of the S&E labor market? What role do foreign students play in meeting these needs? Are American students dissuaded from choosing careers in S&E? What threat do foreign universities pose to the predominance of American universities in S&E?

The Panel reviewed trends in enrollment and graduation rates for S&E degrees, the proportion of each accounted for by foreign students, comparable trends in S&E degrees produced by foreign universities, possible qualitative differences between foreign and U.S. S&E degrees, and such factors influencing student career choices as time to obtain different degrees, funding support, and differences in median entry level salaries for various S&E and non-S&E occupations over the last ten years. Data indicate that:

- The proportion of total undergraduate enrollments and degrees awarded in S&E fields has remained constant over the last 20 years, while the proportion of S&E undergraduate degrees awarded to foreign students declined.

- Graduate enrollments in S&E fields increased, but there was substantial variation across fields. Moreover, foreign students accounted for an increasing proportion of graduate S&E enrollments. Although this trend was interrupted by the decline in first-time graduate enrollments of foreign students in S&E fields from 2000 to 2003, the interruption appeared temporary as foreign student first time S&E enrollments rebounded in 2004 and 2005.

- Foreign production of S&E undergraduate and graduate degrees surged over the last two decades, especially among Asian countries, with growth rates substantially greater than the U.S. However, the U.S. still produces almost twice as many undergraduate engineering, computer science and IT degrees, relative to total population, as China and over five times as many as India. Although difficult to measure, students in S&E programs in the U.S. may be better trained than their foreign university counterparts.

Increased production of S&E degrees seemed sufficient to meet growing U.S. demands for high-skilled S&E workers, providing little support for the view that American businesses were forced to off-shore high-tech services—notwithstanding the increased use of such workers under H-1B and L-1. Similarly, limited extent of off-shoring did not appear to adversely affect American student S&E career choices, or the ability of the university system to produce new graduates.

A word of caution: Continued globalization can directly impact both American student career choices and the future production of S&E graduates from U.S. universities. A critical challenge for U.S. universities is the intensified competition for the best and brightest S&E students from increasing centers of scientific knowledge and S&E higher education in a more integrated global

economy. Recent enrollment trends indicate that visa challenges that new foreign students faced immediately following 9/11 seem to be ebbing, but barriers remain for those who wish to remain in the United States following graduation.

The Panel recommends that:

- **The President and Congress reexamine policies that limit or impose barriers on foreign students who seek S&E education in the United States, and who wish to remain in the country once their education is completed.**

- **Universities strengthen their capacity to produce S&E graduates in a more competitive global labor market.**

- **The Department of Homeland Security modify existing administrative data systems and data elements collected to track the subsequent work and residency choices of graduating foreign students.**

THE ECONOMIC EFFECTS OF IN-SHORING

Concerning economic effects of services "in-shoring," the obverse of services off-shoring, the Panel asked: How has foreign direct investment offset the effects of off-shoring?

Contributions of "in-shoring" activity to the U.S. economy and employment must be considered in any comprehensive assessment of off-shoring. As noted in the Panel's first report, "trade and investment flow in both directions between trading partners;"[4] these flows can be affected by policy interventions intended to address other perceived problems.

The Panel analyzed the amount of foreign direct investment in the United States from 1980 to 2004, and assessed its effect on employment and value added within U.S. affiliates of foreign companies. This included affiliated trade in research, development and technical (RDT) services for U.S. MNCs and their foreign affiliates relative to that between foreign MNCs and their U.S. affiliates. The Panel found that:

- Employment in U.S. affiliates of foreign MNCs increased substantially from 2 million in 1980 to 5.6 million in 2004.

- U.S. affiliates were more concentrated in manufacturing activities than U.S. firms, and by 2004 accounted for 11.8 percent of total U.S. manufacturing employment. Manufacturing employment for U.S. affiliates increased between 1980 and 2000, and then began to decline, unlike total U.S. manufacturing employment which declined by more than 4.4 million over this period (more than 23 percent).

[4] National Academy of Public Administration, *Off-shoring: An Elusive Phenomenon*, January 2006, p. 84.

- U.S. affiliates of foreign MNCs accounted for an increasing share of U.S. private industry value added over the period, from 3.8 percent in 1988 to 5.7 percent in 2004.

- The trade surpluses in RDT services for non-bank U.S. affiliates increased from $2.4 billion in 2001 to $5 billion in 2004 and were larger than those generated by U.S. MNC parents for each of the last four years.

The Panel recommends that:

- **Policymakers include contributions of "in-shoring" activity to the United States economy, specifically employment levels, in any comprehensive assessment of the economic effects of off-shoring.**

CHAPTER ONE

INTRODUCTION

This is the third Academy Panel report on services off-shoring.[5] Although concerns about impacts of international trade on the U.S. economy are not new, what distinguishes today's concerns is the focus on the services sector, particularly white collar, high-tech jobs previously considered less vulnerable to international trade and potential migration overseas. These concerns led the House Appropriations Subcommittee on Science, State, Commerce and Justice[6] to provide funding to have the National Academy of Public Administration (Academy) comprehensively study off-shoring.

The first report, *Off-Shoring: An Elusive Phenomenon*, defined the phenomenon broadly encompassing various factors that account for services off-shoring and found little consensus among previous studies about the extent and impact of off-shoring. The second report, *Off-Shoring: How Big Is It?,* using micro-level data, found that services off-shoring was much smaller over the 1999-2003 period than popular perceptions would suggest.

This report examines the potential economic effects of services off-shoring, particularly high-tech services. It focuses primarily on high-tech services because many recent anecdotes about services off-shoring have stressed the perceived loss of high-tech, Science and Engineering (S&E) jobs; and these workers and their high-tech services are critical contributors to productivity improvements and technological advancements underlying economic growth and prosperity. The report also examines the relationship between services off-shoring and the much broader expansion of economic globalization. The report assesses effects of services off-shoring and economic globalization on the S&E labor market, student career choices, U.S. university system's ability to meet future needs for high-skilled workers, and role of temporary high-skilled foreign workers, as well as the potentially off-setting economic effects from in-shoring—investment of foreign capital in the United States.

To assess fully the economic effects of services off-shoring, we first determine its relationship to expanding economic globalization. This relationship then establishes an appropriate context for reviewing each of the other key issues in the report.

SERVICES OFF-SHORING—ONE COMPONENT OF GLOBALIZATION

Because they are only one of many factors contributing to the increasing integration of separate national economies into the global market, off-shoring's economic impacts should be assessed in a broader context. A globalized S&E labor market responds differently to supply and demand than does a purely domestic one. These supply and demand factors alter labor market

[5] The first report, *Off-Shoring: An Elusive Phenomenon*, and the second, *Off-Shoring: How Big Is It?*, are available at www.napawash.org.

[6] In January 2007, Congress renamed this the Appropriations Subcommittee on Commerce, Justice, Science, and Related Agencies.

performance and thus affect business decisions to off-shore. Similarly, greater global integration can promote new centers of technical expertise and learning, creating challenges for the U.S. university system and greater opportunities for student career choices and businesses decisions to off-shore high-tech services. Expanded trade and investment flows associated with globalization only reinforce the need to consider employment and other economic effects of "in-shoring" in assessing services off-shoring.

Defining Globalization

"Globalization" describes another complex, dynamic process with multiple dimensions. Most observers focus on economic factors within the process that have stimulated economic integration of national markets. Others have noted that globalization involves more than simply economic change. In addition to cultural and other institutional changes, greater integration can increase vulnerability to the spread of contagious diseases, terrorism, and other disorders. Combined with these challenges, increased vulnerabilities explain the anxiety, disparate views, and controversy generated by globalization.

The Organization for Economic Cooperation and Development (OECD) suggests that "globalization has been widely used to describe the increasing internationalization of markets for goods and services, the financial system, corporations and industries, technology and competition."[7] Most observers note the acceleration of globalization over the last decade, attributing this to political and social reforms flowing from the collapse of the communist system in the Soviet Bloc, emergence of the previously isolated or restricted economies of India and China onto the world stage, and economic transformations of the so-called "Asian tiger" economies. Others emphasize the role of economic liberalization and technological change. OECD, for example, attributes this acceleration to three major economic forces: liberalization of capital movements and deregulation of financial services, further opening of markets to trade and investment, and pivotal role played by information and communications technologies

Implications of Globalization

Growth in international trade and foreign investments among world trading partners has been well-documented. Trade in goods and commodities overshadows trade in services in total world and U.S. trade data, although services trade has been increasing, especially for the U.S. While some may debate whether the pace of change will continue to accelerate, economic and other forces driving globalization will stimulate further changes and need to adapt and respond.

Some observers note the impact globalization will have on the economic prospects of workers. Expanding information and communication technology (ICT) sectors in developed and developing economies have stimulated knowledge dissemination and other intangible capital assets, a driving force for future growth and productivity improvements. Innovation, invention and ability to adapt new knowledge to the development of marketable products and services will be necessary for economic prosperity. As the President's Council of Advisors on Science and Technology (PCAST) concludes, "the big winners in the increasingly fierce global scramble for supremacy will not be those who simply make commodities faster and cheaper than the

[7] OECD, *Measuring Globalization: OECD Handbook on Economic Globalization Indicator,* 2005, p. 16.

competition. They will be those who develop talent, techniques and tools so advanced that there is no competition."[8]

PCAST's conclusion about a knowledge-based foundation for future manufacturing activities applies to the growing services sector that has led recent economic growth for the U.S. and most other developed economies. The Council on Competitiveness notes, "the importance of innovation has grown in recent years as more and more of the value generated in the economy is captured by those who create, possess and apply new knowledge."[9] This has increased the importance of high-tech services that embody innovation and the scientific, technical, engineering and mathematics (STEM) workforce. This explains increased public concerns about reported increases in services off-shoring, especially off-shoring of high-tech services, that deplete this capacity.

Services Off-Shoring and Globalization

Services off-shoring has contributed to and been affected by globalization. Services off-shoring due to U.S. business restructuring will increase services imports. Services off-shoring due to global expansion increases services activity in recipient countries and adds to services exports as foreign-produced services are exported.[10] The extent of services off-shoring due to business restructuring remained small over the 1999-2003 period, however. Growth in services off-shoring due to global expansion was much more pervasive among U.S. multinational corporations (MNCs).

Globalization also affects services off-shored by changing world demands for services, access to markets, and distribution and relative costs of inputs to produce services. Increasing demand can be met through additional U.S. services exports, more services off-shoring due to global expansion, or some combination. More access to foreign markets may increase the U.S. export share of services demanded, depending on the relative production costs and other factors (e.g., degree of direct interaction with service recipients needed). For these reasons, economic impacts from U.S. services off-shoring examined here will be evaluated in the broader context of globalization.

MAJOR POTENTIAL IMPACTS OF SERVICES OFF-SHORING

To assess services off-shoring's impact on workers, the economy, and the university system's ability to meet critical, high-tech skill needs, the Panel addressed the following key questions:

[8] President's Council of Advisors on Science and Technology**,** *Sustaining the Nation's Innovation Ecosystems: Report on Information Technology Manufacturing and Competitiveness*. January 2004, p. ii.
[9] Council on Competitiveness, Competitiveness Index: Where America Stands. November 2006, p. 58.
[10] The second report, Chapter 6, found that most of the services off-shored due to global expansion remained within the host country, although some were exported primarily to other MNC affiliates in other foreign countries.

- What is the effect of S&E[11] labor market conditions on services off-shoring? **(Chapter 2)**

- What role do temporary foreign workers have in meeting domestic labor market needs for specific skills and/or fostering services off-shoring? **(Chapter 3)**

- What effect does services off-shoring have on American student S&E career choices and the ability of the U.S. university system to meet domestic market S&E labor needs? **(Chapter 4)**.

In the off-shoring debate, often overlooked is in-shoring—investments by foreigners in the U.S. economy that sustain or expand economic activity and employment—activities counterbalancing potential economic losses from off-shoring. The Panel asks,

- What are the employment and other impacts of "in-shoring"—"foreign firms shifting service and manufacturing activities to the United States" on the economy? **(Chapter 5)**.

S&E Labor Markets and Services Off-Shoring

Debate about whether there are periodic shortages of S&E workers in the U.S. labor market continues unabated. This issue, in turn, raises concerns about how businesses address uncertain S&E labor market conditions—specifically, whether they are forced or encouraged to shift high-tech service operations overseas to secure the skilled labor force they cannot obtain domestically. Some economists have questioned the existence of periodic shortages. Globalization of labor markets introduces greater uncertainty to the issue. In this report, we review the evolution of the U.S. S&E labor market, and examine changing conditions and trends for globalization, especially as they relate to growing domestic and foreign demands for and supplies of S&E workers.

Role of Temporary Foreign Workers

Temporary foreign workers affect services off-shoring in two ways. Some argue that by meeting U.S. business demands for skills in short supply, they obviate the need to off-shore. However, this suggests that high-skilled foreign workers (and technically-trained foreign students) returning to their native countries expand supply of trained S&E workers overseas, often facilitating U.S. firm decisions to off-shore high-tech services.

Temporary workers are admitted to the United States under a variety of visa programs. The two visa classes critical for assessing effects of temporary foreign workers on services off-shoring are the L-1 visas for intra-company transfers and the H-1B visas for specialty occupation workers. Visa programs provide a means for attracting high-skilled S&E workers and for retaining those foreign S&E graduates who wish to work and remain in the U.S. to help meet business needs for high-skilled labor. In the more intensely competitive market for these high-skilled workers that

[11] The occupation category for S&E workers covers a broad swath of people and is sometimes referred to as "Scientific, Technological, Engineering, and Mathematical" (STEM) professions. These include engineers (already a broad category), mathematicians, computer scientists and analysts, those in the life sciences (medical scientists, chemists, physicists, and the technicians that work with them) in addition to social scientists (economists, sociologists, and urban planners).

expanding globalization has spawned, these programs become even more important in attracting and retaining these workers to meet growing U.S. needs and deterring the need to off-shore high-tech services.

To assess the role of H-1B and L-1, it is first necessary to identify how many are actually working in the United States, how long they remain, the types of jobs (occupations) they have and their compensation relative to other comparably-skilled U.S. workers. Unfortunately, administrative databases on temporary foreign workers cannot identify how many temporary workers are actually employed in the U.S. during any specific period. Nonetheless, administrative data provide insights on demographic characteristics of temporary foreign workers. These workers are younger than U.S. S&E workers generally, and the majority of the new H-1B visas issued annually go to foreigners already in the U.S., primarily foreign students graduating and looking for U.S. work, and foreign temporary workers seeking to extend their temporary work visas.

Off-Shoring, Career Choices and University Production of S&E Workers

Some observers have suggested that off-shoring of certain high-tech services activities, in conjunction with the role of temporary foreign workers and foreign students, has reduced the relative economic attractiveness of S&E careers for American students. This has created additional concerns about the U.S. university system's ability to meet the domestic economy's future needs for high-skilled, technically competent, S&E workers. Some note the current U.S. dominance in developing, educating and employing S&E workers will be increasingly challenged by India and China in supplying workers to the global economy. Foreign students play a pivotal role, as does the expansion of S&E training in foreign university systems, in how well the U.S. university system can meet the need for high-skilled S&E workers. Continued success has clear implications for future off-shoring of high-tech services.

Similar questions to those for temporary foreign workers, regarding their employment, residence and citizenship choices after completing their education, apply equally to foreign students. To address these, we review enrollment and graduation trends for S&E students at U.S. and foreign universities, as well as potential qualitative differences in graduates produced. We assess factors affecting American student career choices, including relative entry level wages for various S&E specialties.

Economic Effects of "In-Shoring"

Because trade and foreign direct investments flow in both directions among trading partners, the economic effects of "in-shoring" also need to be examined in any comprehensive review of services off-shoring. This report examines affiliated transactions between foreign corporations and their U.S. affiliates to assess their effect on the U.S. economy. The focus is on net change in employment among those U.S. affiliates, amount of value added created, and their contribution to net exports of high-tech services thus helping to maintain the U.S leadership role in these types of services. A major question is whether these in-shoring economic effects substantially off-set any economic and employment losses from services off-shoring.

CHAPTER TWO

WHAT IS THE EFFECT OF SERVICES OFF-SHORING ON THE S&E LABOR MARKET?

Science and engineering (S&E) workers and the services they supply are key sources of innovation, invention, and technological advancements, the engine driving America's past economic growth and prosperity. This pivotal role helps explain public anxiety surrounding perceived increases in services off-shoring, especially in high technology. While some concerns focus on the number of well-paying S&E jobs that may be lost due to services off-shoring, others worry more about the broader impact on America's ability to retain its competitive advantage in knowledge creation, innovation and technological change.

This chapter answers two broad questions about the S&E labor market:

1. What do trends in and the composition of the S&E labor market reveal about globalization and potential for off-shoring high-tech services?

2. How can the U.S. respond to the challenges and opportunities posed by increasing globalization to retain its competitive position in developing, maintaining and growing its S&E labor force, and reduce the need or incentive to off-shore high-tech services in the future?

Regarding Question 1, the Panel finds that the S&E labor market has proved resilient in responding to a number of significant, recent economic shocks and continues to meet the U.S. economy's growing demands for high-skilled S&E labor. In other words, there is little evidence that an insufficient supply of high-skilled S&E labor has forced American businesses to extensively off-shore services to secure necessary skills. The Panel also finds that economic globalization has fostered a more integrated world S&E market, with emerging centers of scientific knowledge and technical skills in diverse areas that are able to connect and interact effectively through improved communication and other information technology.

On Question 2, the Panel believes that America's previous position as a predominant center of scientific knowledge and technological advances will not necessarily continue under increasing globalization. This challenge to previous U.S. preeminence in generating technological advances and other innovations will be accompanied by intensified competition for high-skilled S&E workers from domestic and foreign sources and the need to respond more quickly to changes emanating from multiple word-wide sources. The U.S. can sustain or devise a new leadership role by strengthening and emphasizing its inherent advantages for entrepreneurial activity, innovation, and application of new techniques for developing marketable goods and services. Responding effectively to the accelerated rates of change expected from a more globally integrated S&E market will require not only enhanced flexibility and adaptability among workers, firms and education and research institutions, but also more effective ways to facilitate adjustment to such changes by those communities and individual workers directly affected. The

costs for those individuals, businesses, and communities bearing the change directly can be substantial and should not be ignored.

There are also implications for services off-shoring. In its second report, the Panel found that services off-shoring due to business restructuring has remained small over the last five years, but has the potential to grow.[12] Expanding economic globalization and an increasingly integrated S&E global labor market may increase the propensity of some businesses to off-shore. How extensively those opportunities for increased services off-shoring are used will depend on the continued effective performance of the U.S. S&E labor market, particularly its ability to attract and retain high-skilled foreign S&E workers and foreign students (see Chapter 4) and the ability of businesses and workers to adapt to change.

To improve our ability to respond to these new challenges and opportunities from expanding economic globalization, the Panel recommends that the President and Congress:

- **Remove legislative and administrative barriers to the flow of high-skilled S&E workers to the United States.**

- **Reassess the effectiveness and applicability of current worker support programs relative to the challenges presented by the global economy.**

TRENDS IN AND COMPOSITION OF THE S&E LABOR MARKET

What do trends in and the composition of the S&E labor market reveal about globalization and potential for off-shoring jobs?

This section:

- provides some perspective on the overall economic environment in which the S&E labor market exists, including recent shocks such as the Y2K crisis, the dot.com boom and bust, the September 11 terror attacks, and the recession,

- examines the composition of the S&E labor market, and

- describes current challenges and trends facing the labor market, reflected in employment and unemployment, wages and retirements.

Defining the S&E Labor Market

S&E occupations, cover a broad swath of workers, including engineers (already a broad category), mathematicians, computer scientists and analysts, those in the life sciences (medical scientists, chemists, physicists, and the technicians that work with them) in addition to social

[12] See *Off-Shoring: An Elusive Phenomenon* and *Off-Shoring: How Big is it?* National Academy of Public Administration, 2006.

scientists (economists, sociologists and urban planners). This report focuses primarily on the engineer and scientist occupational components.

There are three ways to characterize the S&E labor force, each producing substantially different estimates of workforce size.[13]

- By occupation. This method is the most commonly used and includes actual work performed. According to the National Science Foundation (NSF), there were 4.9 million S&E workers in 2003.

- By education. Using the highest degree earned to classify workers yielded 11.0 million S&E workers in 2003. This approach takes into account individual skill levels and recognizes that not all those with S&E skills work in S&E occupations. [14]

- By need for knowledge. This perspective involves individuals reporting that their jobs require at least a bachelor's level knowledge in S&E.[15] There were 12.8 million workers in this category in 2003. This approach also extends the education approach by recognizing that individuals may posses S&E skills along with additional higher level skills (e.g., an MBA) and that both types of skills are needed in their current (non S&E) occupation.

Other researchers combine occupation and education as criteria for high-skilled fields, arguing it better captures characteristics of high-skilled immigrants.[16] Using this method, Lowell estimated a professional labor force of 39.9 million—including S&E and other high-skilled workers—between the ages of 25 and 64, with immigrants comprising 11 percent of the total.[17]

There is some disparity in defining the S&E workforce. As a consequence, researchers and policymakers often talk past one another and come to very different conclusions when debating globalization and off-shoring.

While acknowledging the usefulness of the various definitions, this report uses occupation, because it most directly ties to job demands for S&E skills. Statistical systems are geared to provide data on the S&E labor market.

Recent Challenges Confronting the S&E Labor Market

Over the past decade, there have been several major shocks to the U.S. economy that may have affected the S&E labor market, several possibly related to increased globalization and may affect off-shoring activity. These shocks make it difficult to sort out independent effects of off-shoring on the U.S. economy. Taken together, though, it becomes clear some have been "positive" for

[13] Science and Engineering Labor Force. Chapter 3, p. 3-6. NSF.
[14] Electronic mail with NSF staff dated 11-07-2006.
[15] For example, a journalist with a scientific publication with a BA in chemistry may self report being a chemist.
[16] Lowell, Lindsay B. *"The Best and the Brightest: Immigrant Professionals in the United States at the end of the 1990s."* Institute for the Study of International Migration. 2005.
[17] Ibid, p. xx.

the S&E labor forces and others "negative." Consequently, economic shocks created both challenges and opportunities.

Y2K crisis. In the months leading up to December 31, 1999, anxiety grew over whether computer chips and operating software manufactured before 1996 that contained only the last two digits for each year would recognize years that did not begin with "19"—that is, "20" (also known as the "millennium bug"). Although most personal computers in the United States were operating on software that had long since been able to calculate dates well into the future, there remained concerns (often fuelled by alarmist media reports) that some industries relying on this older systems software, especially electrical and finance industries, would be crippled. Because of the perceived magnitude of the problem, and need to review and test individual systems before the year 2000, there was an increase in the demand for computer programmers and others capable of reviewing systems code to test existing systems and perform remedial work. Although the S&E workforce surged to meet demand, some of the supply increases were temporary. The statutory caps on temporary, high-skilled foreign workers under the H-1B visa program more than doubled from 65,000 to 125,000. However, the U.S. S&E market could not meet all the substantial and concentrated increased programming demands and some firms began to shift these activities off-shore.

Because this Y2K demand increase was temporary and heavily concentrated, demand for programming skills dropped during the early months of the New Millennium. The surge and subsequent decline in temporary demand and the shift of some programming activities to off-shore locations placed some unusual stress on the U.S. S&E labor market.

Dot.com boom and bust. From 1997 through 2001, business commerce on the Internet skyrocketed. Traditional and new retail businesses began sales over the Internet and IT vendors created technologies to assist them. Prospects of making money in new business models seemed to create irrational investment behavior driving stock prices to unprecedented levels, while at the same time attracting legions of entrepreneurs in the market. S&E workers not only were in high demand for growing companies, they also saw opportunities to startup their own ventures. The dot.com boom created a dot.com bubble which burst after 2001, contributing to recession. What compounded the economic impacts was that it occurred simultaneously with the surge in demand for computer programming skills due to the "Y2K" crisis and the subsequent decline in the demand for those skills after 2000.

September 11. Although the tragedy of September 11 is most staggering in terms of lives lost, its economic impacts were devastating. After stock markets re-opened on September 17th, the Dow Jones Industrial Average fell more than 7 percent in the first day and by more than 14 percent by week's end, the largest one-week point drop (1369) in its history. According to BLS, 462 extended mass layoffs were attributable to September 11 displacing nearly 130,000 employees. In addition, the attacks imposed tremendous losses on the airline, insurance, tourism and travel related industries. At the same time, spending for first responders and homeland security increased at all levels of government.

Economic recession and recovery. Following the dot.com bust, the U.S. economy began slowing. In their periodic analyses of business cycles, the National Bureau of Economic

Research (NBER) claims that the economy did not peak until March 2001, however.[18] After this point, employment, industrial production, real manufacturing and trade sales as well as real personal income (less transfers) either stagnated or declined. These trends were not contained until November 2001, a time at which NBER claims the most recent recession came to a close, yet real expansion of the overall economy slowed.[19] Despite a 4 percent rise in Gross Domestic Product (GDP) and the fact that personal income as well as manufacturing and wholesale/retail sales had surpassed their pre-recession peaks, payroll employment and industrial production remained well below their pre-recession peaks for over two years.

Much has been written about the "jobless" recovery associated with the 2001 recession. Total U.S. employment grew 1.6 million (1.2 percent) from 2003 to 2004 and another 2.4 million (1.7 percent) from 2004 to 2005. The total civilian unemployment rate over this period declined from 6.0 percent in 2003 to 5.1 percent in 2005. However, virtually all of the employment increases have been in the services sector as private employment in manufacturing fell another 0.23 million from 2003 to 2005, while service sector employment increased 3.3 million—accounting for almost 83 percent of the total employment increase.[20]

Although manufacturing employment bore the brunt of employment losses and has continued its long structural decline over several decades, the adverse environment added to the stress already imposed on the S&E labor market by the Y2K crisis and the dot.com boom and bust.

S&E Labor Market Trends and Performance

This section examines S&E labor market trends—total employment, mix of S&E occupations, employee compensation levels, and S&E unemployment rates—over the past 20 years to assess how that market adjusted to recent economic shocks and challenges.

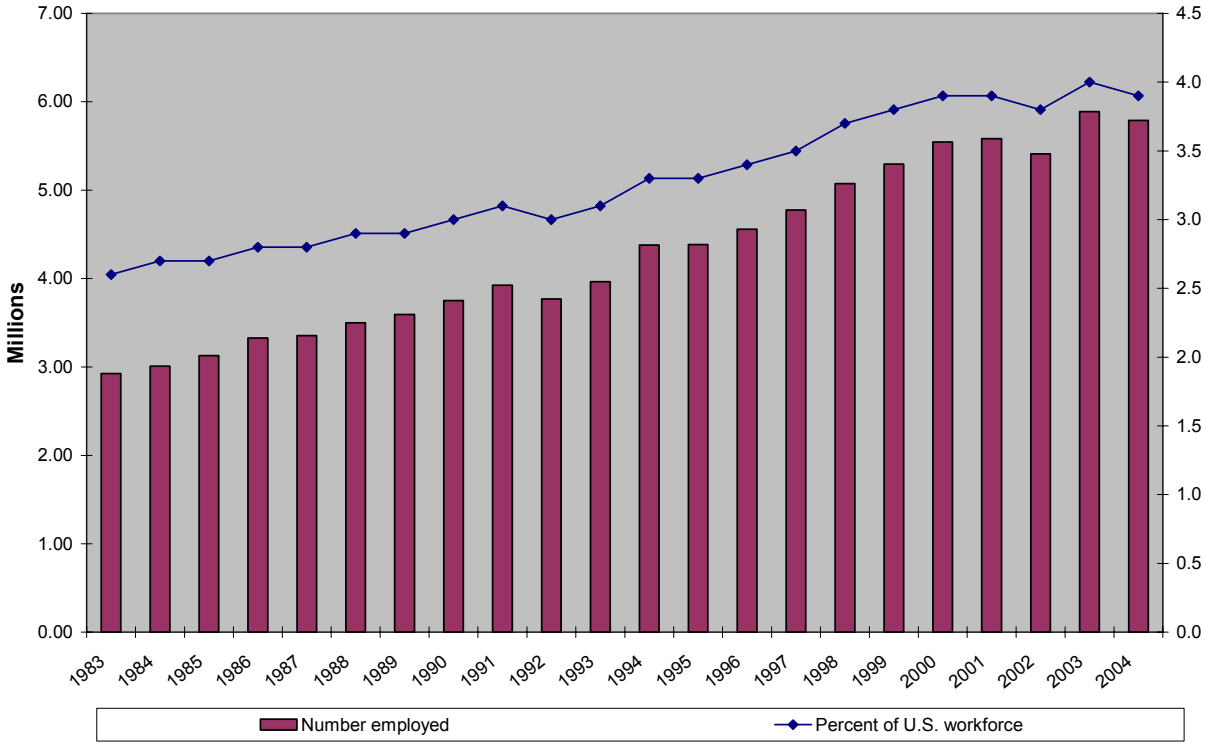
S&E Employment Is Generally Increasing

S&E employment generally increased over the past two decades in both absolute terms and relative to total employment. In 2004, 5,789,000 workers were employed in S&E, constituting 3.9 percent of the entire labor force. The number of workers in S&E steadily increased over the past two decades (see Chart 2-1). In 1983, S&E workers numbered about 2.9 million, comprising 2.6 percent of the workforce. More recently, this general growth trend for S&E employment has become more uneven, remaining unchanged from 2000 to 2001, and then declining in 2002. These changes reflect the impact of the 2001 recession—as the dip in 1992 S&E employment was the response to the 1991 recession. But the deeper decline in 2002 and the additional decline in 2004 may also reflect longer term responses to the dot.com bust, and other recent economic shocks. S&E employment rose again in 2003 to a new peak, but fell off slightly in 2004, reflecting an economic recovery that initially produced fewer new jobs than

[18] See the full report on the NBER website, <http://www.nber.org/cycles/november2001/>, accessed 5/18/06.
[19] See the full report on the NBER website, <http://www.nber.org/cycles/july2003.html> accessed 5/18/06.
[20] FY 2006 Economic Report of the President, Tables B-35 and B-46.

expected.[21] The economy is more vulnerable to off-shoring when demand for S&E labor is increasing and supply is unable to meet needs.

Chart 2.1
S&E Employees in U.S. Workforce, 1983-2004



Growth across all S&E occupations is not uniform, suggesting that globalization and off-shoring have disparate effects. Aggregate S&E employment growth from 1983 to 2004 was similar to the employment increases realized by other professionals and the overall continued growth in service sector employment. Dramatic expansions for the IT and telecom sectors, in the late 1980s through the mid-1990s, likely account for some of this S&E employment growth. Growth rates differed among specific S&E professions over this period. Given the IT and telecom expansions, it is not surprising that computer-related occupations lead the growth. According to the Commission on Professionals in Science and Technology (CPST), the fastest growing fields included "computer systems analysts and scientists," followed by "physical scientists," with "medical scientists" a distant third. CPST identified drafting occupations, followed by nuclear and petroleum engineers, as the professional groups experiencing the greatest recent employment declines.

[21] National Science Foundation, *Science & Engineering Indicators,* 2006, <http://www.nsf.gov/statistics/seind06/pdf_v2.htm> Appendix Table 3-3 accessed on 5/18/06.

Foreign-Born Workers Constitute an Increasing Share of S&E Labor

To meet labor demand, the economy appears to rely more and more on skilled S&E foreign-born workers. The percentage of foreign-born college graduates (including both U.S. and foreign degrees) in S&E occupations increased from 11.2 percent in 1980 to 22.4 percent in 2000.[22] In 2003, the percentage of foreign-born college-educated workers grew to 25.0 percent.[23] Reliance on foreign born S&E workers increases with the level of degree held. Foreign born workers holding doctoral degrees accounted for nearly 40 percent of doctorates in S&E occupations in 2003. In some specific fields foreign born S&E workers are a majority of the workforce. Currently, these fields are in the engineering and computer science disciplines and include computer science (57 percent foreign), electrical engineering (57 percent foreign), civil engineering (54 percent foreign) and mechanical engineering (52 percent foreign).[24] Should the S&E labor market be unable to meet demand for workers—domestically or through foreign recruitment—off-shoring may be one alternative for U.S. industry.

Entry-Level Wages Are Increasing

Trends generally show higher earnings for recent S&E degree recipients relative to those with non-S&E degrees, supporting the notion that demand for S&E workers is exceeding, to some extent, supply.[25] Table 2-1 reports NSF data showing the inflation-adjusted change in entry-level, median salary by degree, field of work and level of highest degree for the period 1993 to 2003. Real entry level salaries for S&E workers increased faster than compensation for other college-educated workers, with the greatest differences occurring for those with engineering and math and science degrees. There were differences by level of degree, however.

Among recent[26] bachelor degree recipients in non-S&E fields, median real salaries grew by only 7.7 percent over the period. In contrast, recent bachelor's degree recipients realized much greater increases in median real salary in all S&E fields. Among master's degree recipients, recent non-S&E graduates earned a greater rate of change in inflation-adjusted median salaries than their counterparts in S&E fields—except for mathematics/computer science graduates. NSF states "these high growth rates in earnings for recent master's degree recipients are indicative of the increasing returns to high skills throughout the U.S. economy during this period."[27]

Increase in real median compensation among recent doctoral graduates was greatest for those in the physical sciences, engineering, and math/computer science fields and lowest for those in the non-S&E, life sciences, and social sciences fields.

---

[22] U.S. Census Bureau PUMS data, from NSF Science and Engineering Indicators 2006.
[23] U.S. Census Bureau American Community Survey data, from NSF Science and Engineering Indicators 2006.
[24] STEM Workforce Data Project: Report #1, *Twenty Years of Scientific and Technical Employment*, <http://www.cpst.org/STEM/STEM1_Report.pdf> accessed 5/18/06.
[25] Chapter 4, p. 20 to 23, also provides an analysis of S&E compensation for entry level workers – those with less than five years of work experience.
[26] Recent degree recipients are those with less than five years of work experience earning an entry level salary.
[27] Science and Engineering Indicators, Chapter 3, p. 3-10.

Table 2-1
Inflation-Adjusted Change in Media Salary 1-5 years after Degree by Field and level of Higher Degree (1993-2003)
(Percent Growth in Median Salary)

	Bachelor's	Master's	Doctoral
Mathematics/computer sciences	28.0 %	54.8 %	18.6 %
Non-S&E	7.7 %	52.7 %	4.0 %
Engineering	34.1 %	47.9 %	19.3 %
Life sciences	24.5 %	42.9 %	0.3 %
Social sciences	15.8 %	32.1 %	4.0 %
Physical sciences	9.5 %	31.8 %	31.9 %

NOTE: Non-S&E fields include the SESTAT categories "non-S&E" and "S&E related."
SOURCE: National Science Foundation, Division of Science Resources Statistics, National Survey of College Graduates (1993) and preliminary estimates (2003).
Science and Engineering Indicators 2006

Much of the increase in real compensation occurred during the early part of the period as the economy's overall expansion continued unabated. As Table 2-2 shows, real salary growth since 1999 was slower for S&E occupations in the aggregate, with all degree levels combined. But rates of change varied significantly among occupations. S&E workers in the computer science and math fields experienced the greatest decline in their annual real salary percentage increases, while engineers had an acceleration of their annual real salary increases during the latter part of this period. Differences are consistent with changing economic conditions present during the latter half of this period, particularly the specific economic shocks directly affecting the S&E labor market and computer analysts and programmers.

Table 2-2
Changes in Median Annual Salaries of U.S. Individuals in Selected S&E Occupations (1993-2003)
(All Degrees)

Occupation	1993	1995	1997	1999	% Change (1993-1999)	Average Annual Change /1	1999	2001	2003	% Change (1999-2003)	Average Annual Change /2
All S&E occupations	37,000	38,000	41,000	46,000	24.3	4.1	46,000	N/A	52,000	13.0	3.3
Scientists	34,500	34,500	38,000	43,000	24.6	4.1	43,000	N/A	50,000	16.3	4.1
Computer/math scientists	38,200	40,000	46,000	55,000	44.0	7.3	55,000	N/A	59,000	7.3	1.8
Engineers	40,000	41,000	45,000	49,000	22.5	3.8	49,000	N/A	59,500	21.4	5.4

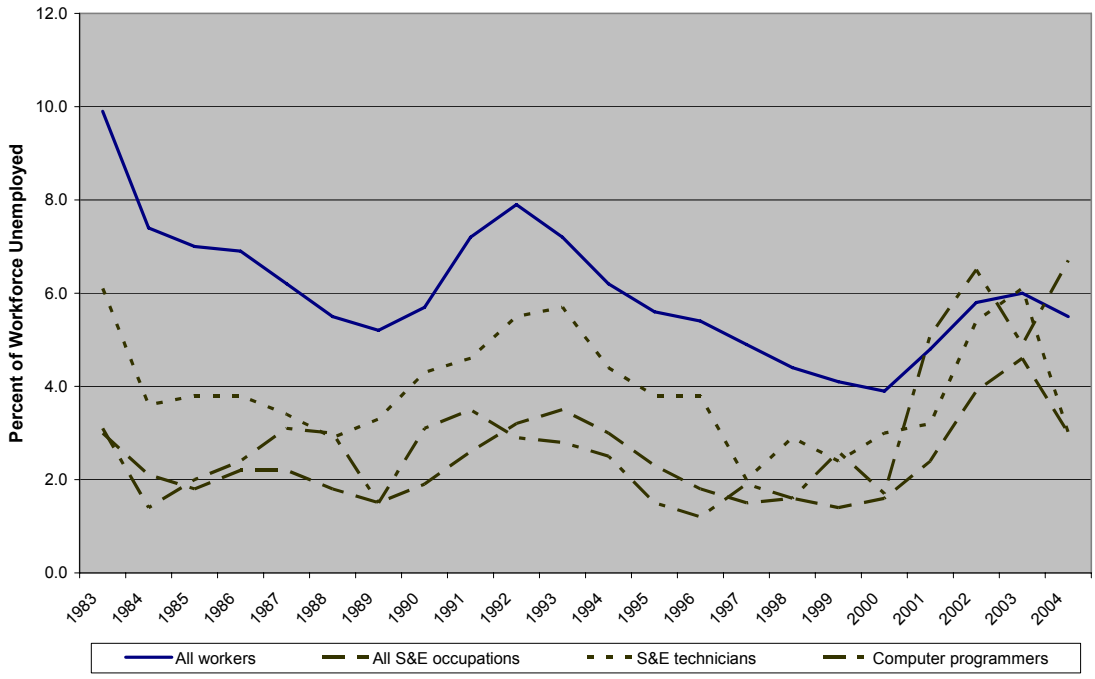
Source: National Science Foundation and Academy staff calculations.
/1 Percent Change (1993-1999) divided by 6.
/2 Percent Change (1999-2003) divided by 4.

Increasing relative wages for S&E workers are sustainable if industries maintain a competitive advantage, usually through increased productivity, continued development of innovative products and services, or more effective use of advanced, cost saving technologies. Foreign competitors frequently have lower cost structures and can adopt cost saving technologies and improve their productivity to further reduce their costs through lower wages, locational advantages and sometimes specialized skills, while maintaining quality. Consequently, an increased emphasis on innovation appears more likely to maintain a competitive advantage to support continued relative wage growth and deter future off-shoring of high-tech services.

S&E Worker Unemployment Rates Remain Low

Historically, unemployment rates for S&E workers have generally been lower, and often substantially lower than the total labor force unemployment rate. This supports the perception that demand for S&E workers exceeds supply. As Chart 2-2 indicates, the unemployment rate for all S&E occupations was 3.0 percent compared to 5.5 percent for the entire labor force in 2004. Over the past two decades, the unemployment rate for all S&E occupations has never exceeded that of the entire labor force, suggesting that throughout this period, S&E workers were more likely to be employed than workers overall,[28] or were able to find new S&E jobs faster, or both.

Chart 2-2
Unemployment in S & E Occupations (1983-2004)



[28] National Science Foundation, *Science & Engineering Indicators, 2006*, <http://www.nsf.gov/statistics/seind06/pdf_v2.htm> appendix table 3-8 accessed 5/18/06.

Data indicate that differences between S&E and total unemployment rates declined over the period and this was more pronounced for some occupations. In fact, computer programmers faired worse than the workers overall at least in 2004, when their unemployment rate (6.7 percent) actually exceed the overall unemployment rate of 5.5 percent. Again, this is consistent with the Y2K and dot.com boom/bust shocks that had direct, substantial impacts on the demand for these skills in subsequent years. It also reflects movement of industry away from computer programming into systems engineering and other high-tech fields that require different or additional skills.

Foreign-born workers, especially those under temporary work visas, are meeting the increasing demand for S&E workers (issues surrounding temporary workers are discussed in Chapter 3). According to NSF, in 2003, the unemployment rate for all S&E occupations was 3.9 percent, but temporary residents in S&E occupations had an unemployment rate of 2.1 percent.[29] In 1993, this reversed: overall S&E unemployment rate was 2.6 percent and temporary residents 4.8 percent.[30] The lower 2003 unemployment rate for temporary residents in S&E occupations was unexpected; but it may reflect a reduction in the number of these types of S&E workers if they returned to their native country (as required by law) when their jobs terminated. Others suggest lower unemployment rates for these workers may reflect a lower wage being earned by them relative to Americans with similar degrees, but this is difficult to reconcile with higher unemployment rates for non-residents during the earlier part of the period.[31] Presence of foreign-born S&E workers, regardless, reduces likelihood of off-shoring at least in the near term.

Retiring S&E Workers Continue to Increase

Demographic data show a large number of S&E workers concentrated in the 50 or older age group, suggesting further pressure on the labor market to meet increasing replacement demand as these aging S&E workers retire. According to the most recent NSF data, 29 percent of S&E degree holders still in the labor force are age 50 or older. Among doctoral degree-holders, 44 percent are age 50 or older. By age 62, one-half of bachelor's degree holders had left the full-time work force. One-half of doctoral degree holders had left by age 66.[32] To meet the increased demand to replace this impending wave of S&E worker retirements, there may be pressure to attract even more foreign-born labor to the U.S. or to produce more workers domestically. If these increases in supply are not adequate, businesses may seek to off-shore some high-tech services to areas where the supply of needed S&E skills is more readily available.

Given the increasing reliance on foreign workers over the past two decades, the U.S. may be better able to accommodate this source of additional supply than other developed countries that are facing similar aging issues for S&E workers. It seems likely that foreign workers will

[29] Based on data from NSF's SESTAT database using the National Survey of College Graduates.

[30] National Science Foundation, *Science & Engineering Indicators, 2006*, Table 3-7, accessed on 5/18/06 <http://www.nsf.gov/statistics/seind06/pdf_v2.htm>

[31] These unemployment rates must be interpreted with caution because both the 1993 and 2003 numbers were based on the 1990 and 2000 census and excludes temporary residents arriving in the country after those years.

[32] This aging S&E workforce phenomenon is not unique to the U.S. Due to low birth rates, the European Union countries and Japan likely face a similar retirement wave of S&E workers in the near future. China's workforce is also aging rapidly because of the "one child" policy.

account for an even greater share of the total S&E workforce in the future. But a key issue will be the ability to continue to attract and retain these foreign workers, especially in an increasingly globalized S&E market if current barriers continue to impede the flow of high-skilled foreign S&E workers and students to the U.S.

INCREASED GLOBALIZATION AND COMPETITIVENESS IN S&E

We turn next to Question 2: how can the U.S. respond to the challenges and opportunities posed by increasing globalization to retain its competitive position in developing, maintaining and growing its S&E labor force, and reduce the need or incentive to off-shore high-tech services in the future? To answer this question we first need to understand the challenges posed by increasing globalization.

Many industries employing S&E workers rely heavily on their capacity to convert knowledge into goods and services that consumers will buy. Many rely on continued innovation to create new and exciting products that attract consumers. Many also rely on technology to reduce the cost of producing goods and services consumers demand. Some thrive on innovation and lower costs of production. If industries lose their capacity to innovate and compete, other industries will replace them. Ultimately, the S&E workforce will be displaced (some through off-shoring) or migrate to more competitive ventures. These more competitive ventures may well be foreign companies or multinational corporations with overseas operations. Three widely-monitored proxy indicators of S&E sector competitiveness include patents held, journal articles produced and expenditures on research and development (R&D).[33]

Intellectual Property Indicators for Foreign Countries Growing Faster than U.S.

The World Intellectual Property Organization (WIPO), in its annual report on patent activity, presents estimates of patent applications for patent offices. The top ten national patent offices ranked according to 2004 patent filings are shown in Chart 2-3. Data ranked Japan at the top in the number of patent applications filed in 2004 with a total of about 375,000. The U.S. ranked second with a total of 325,000 patent applications. China which ranked fifth with 100,000 patent applications had a seven-fold increase in patent filings over a ten-year period[34]—an increase far exceeding those for any of the three major patent offices. The U.S. had the largest share of non-resident patent applications (about 40 percent). The Organization for Economic Cooperation and Development (OECD) reported that an average of 15 percent of all inventions in OECD countries was owned or co-owned by a foreign resident from late 1990s to early 2000.[35]

Table 2-3 shows annual patent applications to the major patent offices—U.S. Patent and Trademark Office (USPTO), Japanese Patent Office (JPO), and European Patent Office (EPO). Patent activity has increased dramatically world-wide over the last decade: annual patent applications to the USPTO increased 67.3 percent with the number of annual applications over

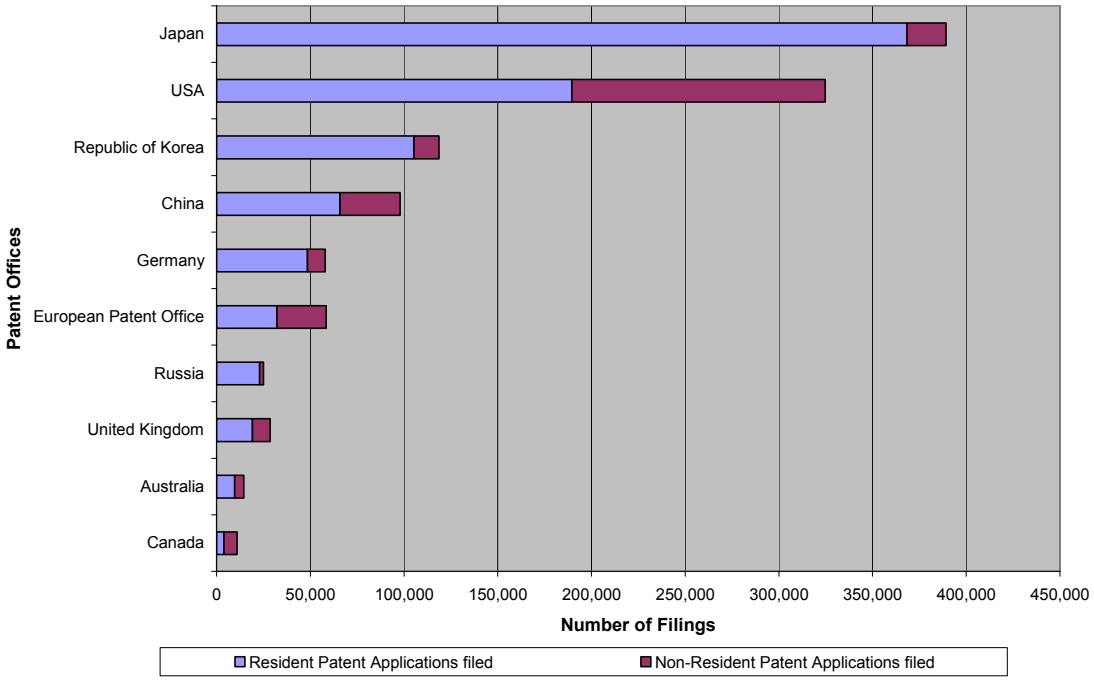
[33] In addition to these indicators, there are others: competitiveness indices, venture capital investments, NASDAQ stock indices, and the like.
[34] *"Statistics on Worldwide Patent Activity (2006 Edition)*. World Intellectual Property Organization, 2006
[35] *Measuring Globalization: OECD Economic Globalization Indicators*. OECD, 2005.

143,000 greater in 2004 than in 1995. The percentage increase in annual applications to the EPO was even larger (196.2 percent), although the actual increase (over 118,500) was smaller than for USPTO. Increases in annual applications to the JPO grew at a more modest 13.8 percent.

Table 2-3
Annual Patent Applications (1995-2004)

Year	USPTO	JPO	EPO
1995	212,377	369,215	60,078
1996	195,187	376,615	64,035
1997	215,257	391,572	72,960
1998	243,062	401,932	82,251
1999	270,187	406,655	89,322
2000	295,926	436,865	100,692
2001	326,508	439,175	110,025
2002	334,445	421,044	106,325
2003	342,441	413,092	116,613
2004[36]	355,527	420,000	178,579

Chart 2-3
Top 10 Offices of Patent Filings in 2004



[36] Differences between WIPO and USPTO reported numbers for 2004 are likely due to recording errors in the offices.

As noted, patent application trends reflect not only the expansion in invention and innovation activities within individual countries but also increasing need for businesses' to protect their intellectual capital in all the major international markets. The high proportion of non-resident patent applications filed with the U.S. likely reflects this latter purpose.

U.S. Share of Journal Article Production/Citations Is Declining

Decline in the U.S. share of S&E article production over the last 15 years and the corresponding increase in the shares from emerging economy workers suggest an expanding globalization of intellectual capital. However, the U.S. has apparently been able to maintain a substantial competitive advantage in the quality of S&E research and its efficiency in producing that research (on a per capita basis) even in an increasingly global market.

The United States, in 2003, produced 30.3 percent of the world's S&E article output, far outpacing its nearest competitor, Japan at 8.6 percent, and economic rivals, China at 4.2 percent, and India at 1.8 percent. However, the U.S. share declined from 38.1 percent in 1988 to 30.3 percent in 2003, as shown in Table 2-4. Emerging economies—China, South Korea, Taiwan and Brazil—accounted for the largest percentage increases in S&E article output, but their initial shares were 1 percent or less.

The number of citations in other S&E articles measures quality of the initial research, its importance in the field and extent of its dissemination world wide. The U.S. share of citations is even larger than its share of output, although that share has also been declining. In 2003, the United States share of citations in S&E articles world-wide was, 42.4 percent; this far outpaced its nearest competitors the European Union, 32.6 percent, Japan, 7.3 percent, China, 1.5 percent, and India, 0.7 percent. Although the U.S. world S&E citation share has declined from 51.8 percent in 1992, at, to 48.0 percent in 1997,[37] that decline is less than the decline in the production of S&E articles. U.S. articles have continued to maintain a high quality standard and are more likely seminal research in the specific S&E field.

The U.S. has also maintained a substantial lead over a number of its major S&E competitors in terms of article productivity by per capita. From 2000 to 2003, the U.S. produced 706.8 S&E articles per million inhabitants. Comparable S&E article output per million inhabitants over this period for Europe was 489.8, Japan—52.8, China—19.2, and India—11.3. But, the United Kingdom, Australia and Canada were more productive than the United States on this measure.

Apparent trends in globalization of intellectual capital may portend increased off-shoring in the future, as industries search for talent that fosters increased innovation and productivity.

[37] See Table 2-6, next page, from the National Science Foundation's Science and Engineering Indicators, 2006 <www.nsf.gov/statistics/seind06/pdf_v2.htm#c5> utilizing Table 5-61 of their appendix.

Table 2-4. Share of S&E world article output (1988, 1996, and 2003)*
(Percent)

Rank and Country/Economy		1988	1996	2003
1	United States	38.1	34.0	30.3
2	Japan	7.4	8.5	8.6
3	United Kingdom	7.8	8.1	6.9
4	Germany	6.3	6.6	6.3
5	France	4.6	5.0	4.6
6	China	1.0	1.7	4.2
7	Canada	4.6	4.1	3.6
8	Italy	2.4	3.3	3.5
9	Spain	1.2	2.1	2.4
10	Russia	na	3.1	2.3
11	Australia	2.1	2.3	2.2
12	South Korea	0.2	0.8	2.0
13	Netherlands	1.8	2.1	1.9
14	India	1.9	1.6	1.8
15	Sweden	1.6	1.6	1.5
16	Taiwan	0.3	1.0	1.3
17	Brazil	0.4	0.6	1.2
18	Switzerland	1.1	1.3	1.2
19	Israel	1.1	1.0	1.0
20	Poland	0.9	0.8	1.0
21	Belgium	0.8	0.9	0.9
22	Turkey	0.1	0.4	0.9
23	Denmark	0.7	0.8	0.8
24	Finland	0.6	0.7	0.7
25	Austria	0.5	0.6	0.7

*Countries/economies ranked by share of world article output in 2003. Articles assigned to country/economy on basis of institutional address(es) listed on article. Articles on fractional-count basis, i.e., for articles with collaborating institutions from multiple countries/economies, each country/economy receives fractional credit on basis of proportion of its participating institutions. China includes Hong Kong. SOURCES: Thomson ISI, Science Citation Index and Social Sciences Citation Index, http://www.isinet.com/products/citation/; ipIQ, Inc.; and National Science Foundation, Division of Science Resources Statistics, special tabulations.
NSF, *Science and Engineering Indicators 2006*, Appendix Table 5-42.

Federal Dominant Share of R&D Spending Is Diminishing

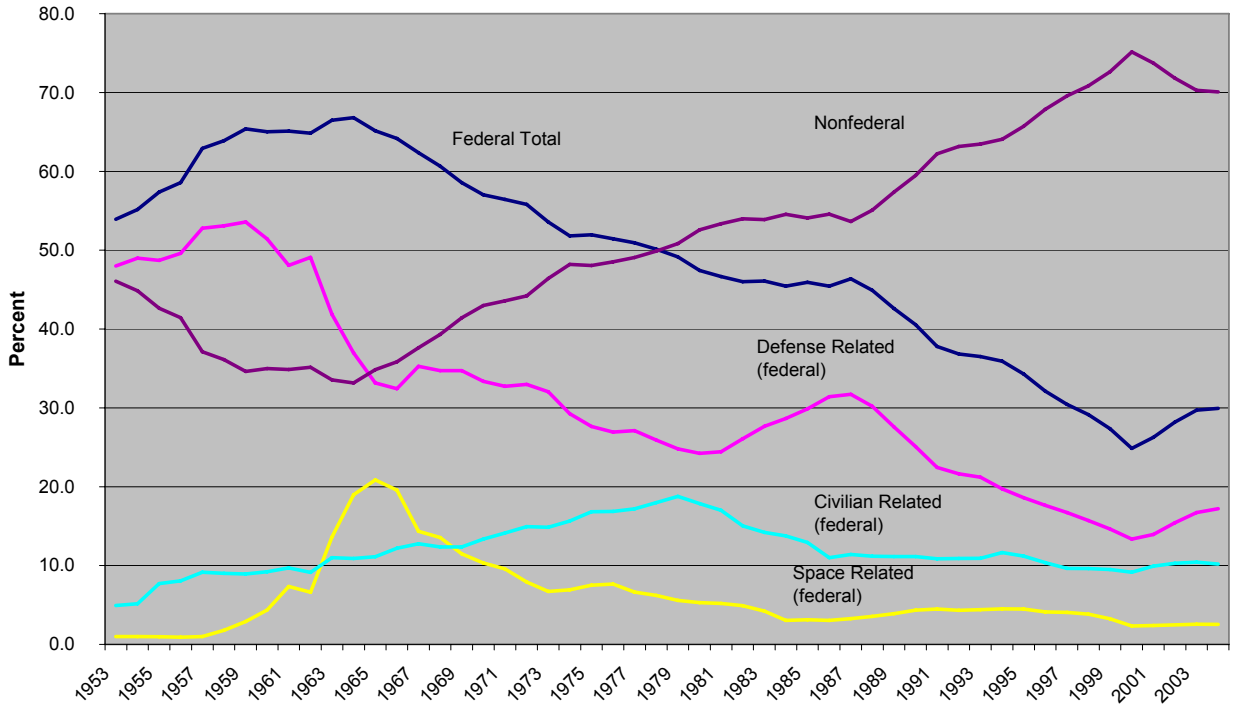
Since 1953, when NSF first began collecting R&D data, the current dollar amount of total R&D spending steadily increased—except for a one-time decline in 2002. Total R&D spending was $291.9 billion in 2003 and is projected to increase to $312.1 billion in 2004.[38] In constant 2000 dollars, total R&D increased 3.9 percent in 2003 and is projected to increase 4.7 percent in 2004. Constant dollar R&D spending has also increased throughout this period, except for a 2.2 percent

[38] Brandon Shackelford, *U.S. R&D Continues to Rebound in 2004*. SRS InfoBrief, NSF06-306 Jan, 2006, p. 1.

decline between 2001 and 2002.[39] This one time decline in 2002 was due to a sizeable decline in industry spending on R&D, primarily in response to the dot.com bust and the 2001 recession. Private industry financed about 64 percent ($199 billion) of projected 2004 R&D spending; the federal government funded 30 percent ($93.4 billion), with universities and non-profit organizations supplying the remainder (about 6 percent).

Non-federal (private industry, non-profits and universities and colleges) R&D spending has increased substantially over time while the federal share has declined (see Chart 2-4). Since 1979, non-federal entities (primarily private industry) have accounted for the majority of R&D spending. Federal R&D spending shares in defense, non-defense and space activities have all declined from earlier highs in the late 1950s, early 1980s and mid-1960s, respectively.

Chart 2-4
Federal and Nonfederal R&D Expenditures as Percentage of Total (1953-2004)



Source: National Science Foundation

R&D spending as a percent of GDP has fluctuated between 2.4 percent and 2.7 percent since 1984.[40] However, since 2001, the R&D spending share of GDP has declined slightly, reflecting a

[39] Ibid., p. 1.
[40] National Science Foundation database. http://www.nsfgov/statistis/nsf06327/database.htm

less rapid increase in industry R&D spending over this period. Federal R&D spending as a share of GDP has increased since 2000, led by health, defense and counterterrorism.

Types of R&D funded by industry, the federal government and others differ significantly (see Table 2-5). Industries accounted for the vast majority of development R&D funding (85 percent), total R&D funding (64 percent), and applied research funding (54 percent). The federal government accounted for a relatively small percentage of R&D funding for development (14 percent), but accounted for a substantial majority of R&D funding in basic research (62 percent) and a substantial proportion (38 percent) of applied research funding. Universities and colleges, and non-profits accounted for a relatively small share of funding in all the R&D categories, with the majority of their funding allocated to basic research. Table 2-5 illustrates the distribution of R&D funding by source.

Table 2-5
U.S. R&D expenditures by funding source (2004)
($ Millions)

	Industry	Federal	Universities & Colleges	Non-Profits	Total
Basic	9,551	36,075	7,579	5,150	58,356
Applied	35,975	25,315	2,883	2,190	66,363
Development	153,498	25,315	633	1,224	180,670
Total	199,025	93,384	11,095	8,565	312,069

Source: NSF, Division of Science Resource Statistics

Although real federal R&D spending on basic research has increased in dollar terms over the past ten years (from $13.9 billion in 1990 to $24.4 billon in 2004, or 75.5 percent), federal share of spending on basic research has declined.[41] Spending on life sciences has accounted for a growing share of federal basic research spending, reaching 58 percent in 2004.[42]

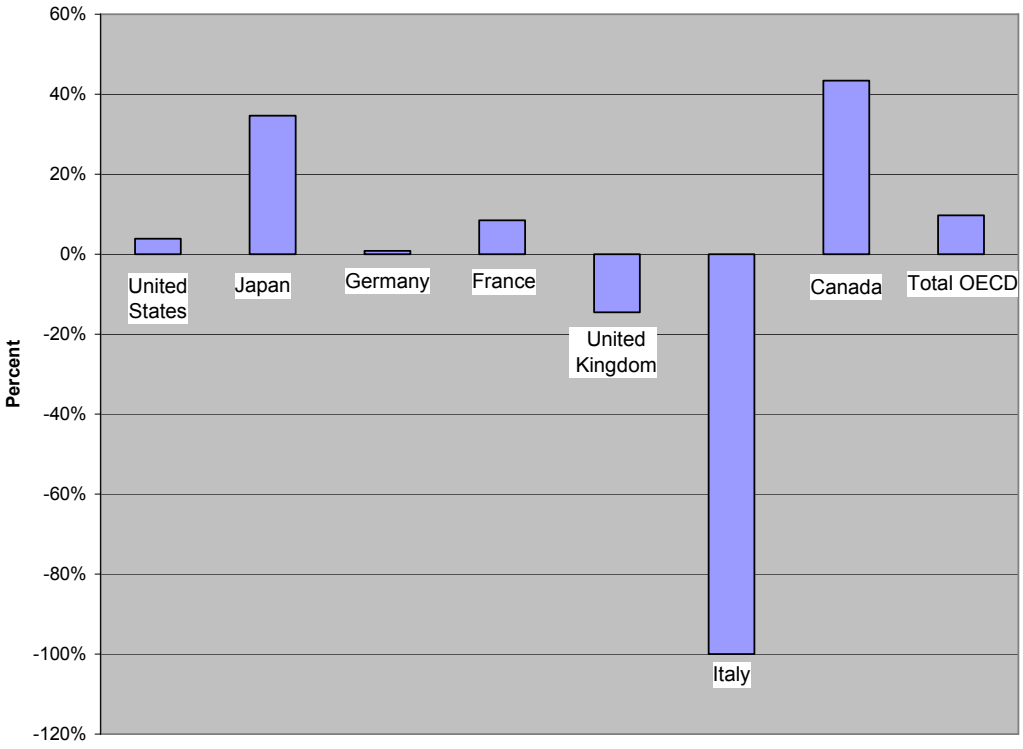
Foreign R&D Spending is Increasing

When compared to the rest of the world, the U.S. spends more (in dollars) on R&D than any other country, but Japan, Israel, Finland and Sweden spend a larger share on R&D as a percent of GDP. Other recent data from OECD also indicate that while China ranked last with 0.07 percent, the U.S. (0.49) ranked fifth behind Israel (0.91), Switzerland (0.72), France (0.53), and New Zealand (0.52) in the share of gross domestic product spent for basic research.[43] At the same time, R&D spending has been increasing more rapidly in a number of other foreign countries (see Chart 2-5).[44] Among OECD countries, Canada (43 percent), Japan (35 percent),

[41] It should be noted that a number of important and widely-used technologies such as bar codes, Doppler radar, the Internet and nanotechnology have been created as a result of federally-funded basic research.
[42] Although federally-funded basic research has continued to increase, most of the increase since 2000 has been oriented toward health and other life sciences and defense.
[43] Organization for Economic Co-operation and Development, Main Science and Technology Indicators (2004).
[44] Ibid.

France (8 percent), and OECD as a whole (10 percent), all experienced higher growth rates in R&D spending than the U.S. (4 percent) over 25 years.

Chart 2-5
Percent Change in OECD Average R&D Expenditures as Percent of GDP (1983-2003)



Source: OECD

Data also indicate that other countries are allocating a higher share of their resources than the U.S. towards basic research. The U.S. ranked fifth in the share of gross domestic product spent on basic research for selected years 2000 to 2002 (see Table 2-6).

Table 2-6
Basic Research Share of Gross Domestic Product, by Country/Economy
Selected Years (2000-2002)
Basic research/GDP (%)

Country	Percentage
Israel (2002)	0.91
Switzerland (2000)	0.72
France (2002)	0.53
New Zealand (2001)	0.52
United States (2002)	0.49
Denmark (2001)	0.44
Australia (2000)	0.40
Japan (2002)	0.39
South Korea (2002)	0.35
Singapore (2002)	0.33
Czech Republic (2002)	0.32
Taiwan (2002)	0.25
Hungary (2002)	0.25
Poland (2002)	0.19
Russian Federation (2002)	0.17
Spain (2002)	0.16
Ireland (2000)	0.14
Mexico (2001)	0.12
Argentina (2002)	0.10
China (2002)	0.07

GDP = gross domestic product
NOTE: Data are for years in parentheses.
SOURCE: Organisation for Economic Co-operation and Development, Main Science and Technology Indicators (2004). *Science and Engineering Indicators 2006*

R&D spending is a key component of the demand for S&E workers as firms adopt or make greater use of technologies or scientific advances created in other countries. As economic globalization continues to expand, further declines in the U.S. share of world-wide R&D spending, for basic research, could affect the future rate of innovation, invention and overall economic prosperity unless the U.S. can access foreign basic research and apply it creatively to new products and services. This is one of the key challenges posed by the increased globalization of the S&E labor market.

Greater world-wide integration of scientific and technical knowledge has also increased the interrelationships for both the supply and demand of S&E workers. Supply of foreign S&E workers can help address increased S&E demands in specific areas through migration or through off-shoring of activities to those areas with more abundant S&E skills. The challenges and opportunities this increased globalization of the S&E labor market presents are examined in the next section.

IMPLICATIONS OF A MORE GLOBALIZED S&E LABOR MARKET

This section examines the potential effects of a more globalized S&E labor market on the U.S.'s current leadership and competitive advantage in various S&E fields and on the future off-shoring of S&E-related services. Continued growth and world wide dissemination of knowledge and information are likely to continue. This will foster the development of additional centers of scientific knowledge and technical expertise. While the U.S. will undoubtedly continue to have a large number of these knowledge centers, its share of the total world knowledge centers and scientific and technical advances they produce is likely to decline. Similarly, large emerging economies of China and India have been and will continue to produce a growing number of college-educated S&E workers, some augmenting the global supply of these workers. (Chapter 4 presents a more detailed discussion of the trends relative to university-educated S&E workers.) At the same time, as their economies expand, their internal demand for S&E workers will grow, absorbing much, if not all, of this expanded supply. This increasingly globalized S&E labor market will present a number of challenges and opportunities for the U.S.

Increased Competitive Pressures from Global S&E Labor Market

National immigration laws still affect the flow of S&E workers across national borders, even in an increasingly global S&E market. Despite current immigration laws that do not facilitate the immigration of high-skilled S&E labor, the U.S. market has able to access the supply of foreign S&E workers in the past to help meet its growing demand for S&E labor. As noted above, the S&E market has become increasing reliant on this foreign labor supply, particularly in a number of engineering fields. This trend is likely to continue. While an increasing supply of foreign S&E workers will help meet some of the U.S. increased replacement demand for retiring workers, it is also possible that this increase could reduce the future growth in wages workers relative to other professional fields requiring advanced training. This, in turn, could encourage talented American students with quantitative skills useful in S&E occupations to become more attracted to other fields of endeavor such as business and law.

Although a number of independent studies have indicated that the global supply of S&E workers will increase substantially, especially from the large Chinese and Indian emerging economies, the amount of that supply available to meet U.S. demands will depend on several factors. As a McKinsey Global Institute (MGI) study points out, only a limited portion of the supply of foreign labor have the language, interpersonal, and other skills needed to meet employment requirements of multi-national corporations operating in global markets.[45] While that portion may increase over time, MGI estimated that only 17 percent of the foreign supply of engineers and 14 percent of the life scientists in their study were suitable for MNC employment as of 2005.

Another critical factor affecting the increasing global supply of foreign S&E worker is the demand for S&E workers from other economies, especially the large emerging economies themselves. As these and other economies grow and increase their R&D spending, their demand for S&E workers will also increase. It is unclear how much of the expanding foreign supply will

[45] Farrell, Diana, *et al*. *The Emerging Global Labor Market: Part II—The Supply of Offshore Talent in Services,* McKinsey Global Institute, 2005, p. 5.

be used to meet growing foreign internal demands for S&E workers, but these growing internal demands will limit the foreign supply available to meet U.S. demands.

In short, U.S. demands for S&E workers will likely have to compete for available supplies not just in the domestic U.S. market but in the global S&E market. In addition, the demand for U.S. S&E workers will be increasingly influenced by external elements (e.g., increased foreign R&D spending and growing foreign demands for similar skills). Pioneering discoveries from additional overseas spending on basic research may be developed into marketable products or services for sale to U.S. or other customers. Alternatively, more efficient software programs developed overseas may be extended to different systems and/or applications in the U.S. increasing the demand for those new systems and their on-going maintenance and support. In both instances, some initial foreign S&E activity would have stimulated increased U.S. demand for S&E workers.

Not all additional foreign S&E activity will generate corresponding increases in U.S. S&E activity. Some will provide increased opportunities for U.S. businesses to off-shore some work. If additional off-shoring is due to business restructuring, some workers may be replaced by increased S&E services imports. If the off-shoring reflects global expansion in U.S. MNC's operations, impact on U.S. demands for S&E workers could be either positive or negative.[46]

Current supply of U.S. S&E workers may also be more sensitive to changes in foreign S&E activity if S&E workers are mobile than other high-skilled workers. This may be important for the U.S., given its reliance on foreign workers and their growing share of the S&E workforce.

Potential supply and demand effects for U.S. S&E workers from a more global S&E labor market raise two additional critical challenges: its ability to attract and retain foreign S&E talent and its response to increased opportunities for off-shoring of S&E services.

Ability to Attract and Retain Foreign Talent in S&E

Ability of the U.S. to attract and retain temporary foreign S&E workers and foreign S&E students training in U.S. institutions will determine whether the country can compete effectively in the global market to support continued expansion of the U.S. S&E work force. Some recent studies have expressed concerns that ability of U.S. universities and employers to attract the best and the brightest from around the world may be declining.[47] Since the terrorist attacks of September 11, the number of foreign students and high-skilled workers entering the U.S. has declined from 772,000 in 2001 to 664,000 in 2003 (14 percent). As noted in other chapters, this decline was attributable to fewer visa applications and increased security requirements. More recent enrollment data for 2004 and 2005 indicate that these initial impediments have been overcome or reduced. But, these initial restrictions occurred at the same time many countries were reducing their barriers to high-skilled immigrants entering their labor markets.[48]

[46] See discussion in Chapter 2 pp. 46-8 in *Off-Shoring:How Big Is It?*
[47] *The Looming Workforce Crisis*. National Association of Manufacturers (2005)
[48] Science and Engineering Indicators 2006 NSF, p. 3-39.

A high percent of foreign S&E students indicate a strong desire to work in the U.S. after completing their education (see Chapter 4). While current data issues preclude an adequate identification of the number of these students actually remaining in the workforce, additional competitive pressures from a more globalized S&E labor market increase need to reexamine current immigration policies to assure the U.S. can compete on a more level playing field with other foreign countries.

Increased Opportunities for Services Off-Shoring

Expansion in foreign R&D spending and increased supplies of high-skilled workers in foreign S&E labor markets likely will increase opportunities for U.S. businesses to off-shore some of their S&E service activities. The economic effects, including the employment effects in the labor market, from any off-shoring of S&E services will vary depending upon the services.[49] If S&E services off-shoring increases in the future because U.S. firms want to expand their R&D operations in markets, they are trying to serve with new products: this may produce complementary expansion in demand for S&E workers. This could occur if a U.S. firm retains basic and applied research in its domestic operations and only off-shores development activities that modify new products or services to improve their marketing in the specific foreign market.

If U.S. firms instead opt to obtain some of their S&E activities from foreign sources that provide more efficient or lower cost services, off-shoring from business restructuring can reduce current S&E employment as firms replace existing S&E workers with imported S&E services. However, these direct employment effects may differ from the long-term net employment impact of services off-shoring due to business restructuring. There will be adjustment costs borne by those S&E workers directly affected. Significance of these adjustment costs depends on how quickly workers become reemployed, and the total compensation received from the new employer relative to prior compensation.

In sum, a more globalized S&E labor market is likely to increase the off-shoring S&E services. It is uncertain how extensively U.S. businesses will exploit these opportunities, or what type of off-shoring will occur. Policies to improve the ability of the U.S. to attract and retain foreign S&E workers, and to emphasize and reinforce the traditional U.S. strengths of entrepreneurship, flexible resilient markets, and individual worker adaptability to change should reduce the need or motivation for business to utilize those additional opportunities, or to exploit the new business opportunities arising from off-shoring due to global expansion.

More Rapid Changes from Multiple Competitors

Development of multiple and competing centers of S&E knowledge and innovation in a more global market is likely to accelerate the rate of innovation and sources producing those changes. Increase in patent filings in other national patent offices and journal articles and citations from foreign sources already observed provide an indication of this potential acceleration and diversification in invention, innovation, and other knowledge-based activities. As the Council on Competitiveness has noted, "the global environment in which innovation occurs is also clearly changing. Millions of researchers from emerging economies are becoming integrated into the

[49] Op.cit., *Off-Shoring; How Big Is It?* Chapter 2 discussion.

global science system as their countries open up to international linkages."[50] Improvements in communications and other IT advances have increased the immediacy of these international linkages, facilitating the flow of intellectual knowledge among individual researchers scattered around the world. Both expansion in the numbers of S&E workers and researchers, and faster and more precise dissemination of information over the internet likely produce more research from diverse locations more quickly than in the past.

Individual knowledge centers will continue to provide new scientific knowledge and technical information needed to support innovation and the development of new products and services. However, the more critical abilities in an increasingly globalized S&E market involve accessing new scientific data from whatever its source and applying it creatively and quickly in the development of new, marketable products and services. Innovative use of new information will become an even more critical engine of economic growth and prosperity, as economic globalization virtually assures that "more and more of the value generated in the economy is captured by those who create, possess, and apply new knowledge, not by those who merely reach high efficiency in the use of well established technologies and operation practices."[51]

FINDINGS AND RECOMMENDATIONS

The Panel finds that:

- The U.S. S&E labor market weathered economic shocks during the early years of this decade, and continued to meet growing demand for high-skilled S&E workers, demonstrating its resilience and adaptability to change. This will become increasingly important in meeting challenges and opportunities in the globalized S&E labor market. Resilience and adaptability must not be taken for granted.

- Increased globalization of the S&E labor force appears irreversible. The U.S. must find ways to maintain its competitiveness. Building, sustaining and growing S&E labor force capacity is key.

- To compete in the global S&E labor market, the U.S. must attract or produce the best and brightest high-skilled workers wherever they may be—domestic or foreign. And, the U.S. must link with labor abroad to promote mutual economic opportunities (e.g., American-educated technicians working in foreign markets provide numerous economic opportunities for partnerships and cooperation).

- In the end, U.S. competitiveness depends on expanding an open economy that promotes innovation, entrepreneurship and productivity necessary to employ the S&E workforce.

[50] Council on Competitiveness, *Competitive Index: Where America Stands.* November 2006, p. 58.
[51] Ibid, p. 58.

To help the U.S. compete more effectively in a global S&E labor market, the Panel recommends that the President and Congress:

- **Remove legislative and administrative barriers to the flow of high-skilled S&E workers to the United States.**

- **Reassess the effectiveness and applicability of current worker support programs relative to the challenges presented by the global economy.**

CHAPTER THREE

WHAT IS THE EFFECT OF TEMPORARY FOREIGN WORKERS ON SERVICES OFF-SHORING?

Temporary foreign workers admitted to the U.S. with a temporary work visa, in part, are intended to address short-term shortages in the U.S. labor market. By meeting U.S. business needs for skills in short supply, temporary work visa programs may reduce services off-shoring. They may also help in spawning innovation and competitiveness in the U.S. economy, as new workers bring new ideas, skills and experiences. Opponents are not so sure. The visa programs might be substituting cheaper foreign labor for more expensive domestic labor. In addition, some fear that the return of high-skilled foreign workers (and technically trained foreign students) to their native countries can enhance the supply of trained S&E workers overseas, thereby facilitating U.S. firm decisions to off-shore high-tech services or promoting competition for U.S. businesses abroad. Temporary workers may also take valuable knowledge and information back to competitors in their countries.

Temporary migrants are admitted to the United States under dozens of specific visa classes, each with their own requirements and time limitations. The two visa classes most critical for assessing the effect of temporary foreign workers on services off-shoring are the L-1 visas for intra-company transfers and the H-1B visas for specialty occupation workers.

This chapter reviews existing administrative data collected by the Departments of Homeland Security and State on the H-1B and L-1 visa programs and other studies of these programs to answer the following questions:

- Has the increased supply of S&E workers from temporary high-skilled foreign workers with H-1B and L-1 visas been sufficient to dissuade businesses from off-shoring high-tech services, in the process stemming the need for off-shoring jobs?

- What other effects have these programs had on the current U.S. S&E labor market and how will this change in an increasingly globalized S&E market?

- Who are the primary beneficiaries of visas–foreign workers seeking access to the U.S.; foreign students seeking to remain in the U.S.; or business firms seeking low cost labor?

- Have the key demographic characteristics of these workers (e.g., age, degree level, occupational specialty, country of origin) changed over time and how different are they from other high-skilled workers in the same occupation and industry?

- Are currently available administrative data sufficient to address these questions?

The Panel finds the following:

- While the H-1B and L-1 visa programs clearly increase the domestic S&E labor force, and appear to have reduced the need to off-shore high-tech services to meet specific skill needs, current data limitations preclude identifying the number of these workers actually employed in the U.S. at any given time.

- These data, however, provide some proximate information on the general demographic characteristics of these beneficiaries.

    - The primary beneficiaries of H-1B and L-1 visa programs are workers from India and China, but many other countries contribute as well.
    - Most are younger than the domestic S&E workforce.
    - Contrary to popular belief, most do not hold PhDs or even graduate degrees.
    - A substantial majority of H-1B beneficiaries were already in the U.S. when they obtained their visa, either as a foreign student, a foreign temporary worker obtaining an extension for an expired visa, or some other status.
    - They are not primarily computer programmers, but they do work in a variety of computer-related fields, as the visa programs intended.

The average salaries for these workers appear to be less than those of white American males in the same occupation, but these differences may reflect differences in age, work experience, and the type of employer between these temporary and other workers.

The Panel recommends that:

- **The President and Congress remove barriers to accepting high-skilled work in the United States and remaining in the United States to continue that work.**

- **The Department of Homeland Security improve its data systems to provide a more accurate accounting of the number of H-1B and L-1 temporary foreign workers actually employed in the United States and address other unanswered key questions about them.**

THE H-1B AND L-1 VISA PROGRAMS

In response to perceived shortages of workers with S&E experience in demand by U.S. industry, Congress, beginning in 1991 (*The Immigration Act of 1990*, P.L. 101-649) legislated special employment visas—H-1B and L-1—allowing foreign workers in S&E fields to temporarily work in the U.S.[52] Work visas are not only intended to address overall shortages in S&E, but are also expected to reduce off-shoring of U.S. jobs.

[52] On October 1, 1991 (fiscal year 1992), the H-1B replaced a similar program, the H-1 visa, which had been utilized as a visa for those with "distinguished merit or ability."

The H-1B visa is a non-immigrant visa, allowing a U.S. company to employ a foreign individual for up to six years [an initial three year approval, followed by a three year continuation]. Because applying for a non-immigration visa is generally quicker than applying for a U.S. *Green Card*, individuals committing to long-term employment in the United States are often initially brought in using a non-immigrant visa such as the H-1B visa.

Individuals do not apply for an H-1B visa themselves. Rather, the employer must petition for entry on behalf of the employee. The H1B visa is designed to be used by employees in "specialty occupations;" or occupations requiring a high degree of specialized knowledge. The equivalent of a job-relevant four-year U.S. Bachelor's degree is required in most cases (this requirement can usually be met by having a three-year degree and three years' relevant post-graduate experience). However, some professionals, such as lawyers, doctors, accountants and others, must be licensed to practice in the state of intended employment—e.g., a lawyer must have passed the relevant state bar exam. The initial visa may be granted for up to three years. It may then be extended, in the first instance for up to two further years, and eventually for one further year, to a maximum of six years. Those wishing to remain in the United States for more than six years may, while still in the U.S. on an H-1B visa, apply for permanent residence (the Green Card). If such employees do not gain permanent residence, when the six year period runs out, they must live outside the U.S. for at least one year before an application is made for them to enter on an H or an L visa (see below).

The L-1 visa is a non-immigrant visa allowing companies operating both in the U.S. and abroad to transfer certain classes of employee from its foreign operations to United States' operations for up to seven years. The employee must have worked for a subsidiary, parent, foreign affiliate or branch office of a U.S. company operating outside of the United States for at least one of the last three years.

Companies operating in the U.S. can apply for an L-1 visa to transfer employees to the U.S. from their overseas operations. Employees in this category will, initially, be granted an L-1 visa for up to three years. Employees sponsored under L-1 visas are either "Managers/Executives" or "Specialized Knowledge Staff." The legal definition of management and executive roles for these purposes is quite strict, and a detailed description of the duties attached to the position will be required. Such personnel are issued an L-1A visa, initially for a three year period extendible in two year increments to a maximum of seven years.

On completing the maximum allowable period in L-1 status, the employee must be employed outside the United States for a minimum of one year before a new application is made for L or H status.

Although the L-1 visa program is not intended to support S&E activity, about 90 percent of visas approved go to computer or information technology firms, leading some to dub it "The Computer Visa."[53]

[53] Office of Inspector General, *Review of Vulnerabilities and Potential Abuses of the L-1 Visa Program*, Homeland Security, 2006 (draft).

CURRENT DATA SYSTEMS FOR TEMPORARY FOREIGN WORKERS

DHS has two principal data bases that provide information on temporary foreign workers with an H-1B or L-1 visa. Both are administrative, work-load oriented. They are not analytical data bases; consequently they do not focus on identifying discreet individual workers and tracking their occupations, other demographic characteristics, length of employment, etc.

The first data base contains admissions and departure data compiled from DHS's I-94 forms. All non-immigrants arriving in the U.S. by air, land or sea are required to complete these I-94 forms, except for Canadian citizens crossing by land, and certain Mexican citizens crossing by land.[54] These arrivals and departures monitor flows into and from the United States. An individual can make several visits to the United States during a year; each visit is accounted for as an arrival (and each exit from the U.S. to return home or to another overseas destination is accounted for as a departure.) This data base contains the name and birth date of the visitor and has a unique identifier for that visit, but no other demographic characteristics on the visitor. An individual making multiple visits can thus have multiple I-94 identifiers and will appear multiple times in the arrival numbers for any fiscal year.

The second data base contains petitioner data from businesses requesting an H-1B or L-1 visa. These petitions identify an individual and specific job that individual will occupy. Data are reported on DHS form I-129 and contain substantial information on the company, including the name, location, type of business (*i.e.* NAICS code) size in terms of total employees and financial data like income, and on the named "beneficiary"—the individual for whom the H-1B or L-1 visa is being requested. The demographic data on each beneficiary include name, birth date, level of education, proposed pay, type of job, country of birth and citizenship, as well as the employer data.

A critical deficiency with these I-129 data is that several firms may be requesting an H-1B visa for the same individual and DHS does not know which H-1B approved petition actual hires the intended beneficiary. Those firms that do not hire the requested beneficiary are not required to turn in their unused approved petition. Thus the number of approved H-1B petitions in any year can contain duplicate requests for the same individual.[55]

Data from both forms are entered into an electronic data base. None of the I-94s completed by visiting individuals and few of the I-129 forms filed by firms seeking H-1B visas for designated workers are submitted electronically. DHS staff indicates that there are significant potential for entry errors, making it difficult to link the data bases or eliminate multiple entries by matching names.[56]

---

[54] Elizabeth M. Grieco, *Temporary Admissions of Non immigrants to the United States: 2005*, DHS Office of Immigration Statistics, July 2006, p. 1.

[55] Although filing fees for submitting I-129 petitions may discourage some duplicative filings, companies may not necessarily know they are competing for the same candidates and, if they truly want the candidate, the filing fee is likely to be irrelevant. Both DHS OIS staff and IG staff indicated that this duplication was a problem with the petition data.

[56] DHS IG staff also confirmed the difficulty in attempting to match names in these data bases due to different configurations of foreign names used by the individuals or companies completing the forms.

Congress has placed caps on the H-1B visa program since 1992 in an effort to control the program's—real or perceived—impact on the domestic S&E labor market as shown in Table 3-1.

Table 3-1
Caps on H-1B Visas

Years (enacted)	1992-1998	1999-2000	2001-2003	2004-2005	2006
Caps	65,000	115,000	195,000	65,000	65,000

But caps have complicated analysis of demand for and approval of visas in at least eight ways:[57]

1. In 1999, Congress exempted thousands working in universities, research labs and non-profits from cap limitations.

2. Some 20,000 visas are reserved for those with graduate degrees from American universities.

3. Some 6,800 visas, under free trade agreements, are reserved for workers from Singapore and Chile.

4. From 1998 to 2000, the Immigration and Naturalization Service (INS) began rolling over cases from one fiscal year to the next.

5. In 2005, INS rolled cases back to 2004.

6. In 2005, unable to expeditiously process cases, the INS ran over the cap by 7,000 cases.

7. Extensions of visas for another three years are not considered under caps.

8. Since two or more firms can petition for the same individual applicants (beneficiaries), there can be multiple or duplicative applications in the total number of H-1B petitions submitted in any fiscal year.

IMPACT OF TEMPORARY FOREIGN WORKERS ON S&E LABOR MARKET

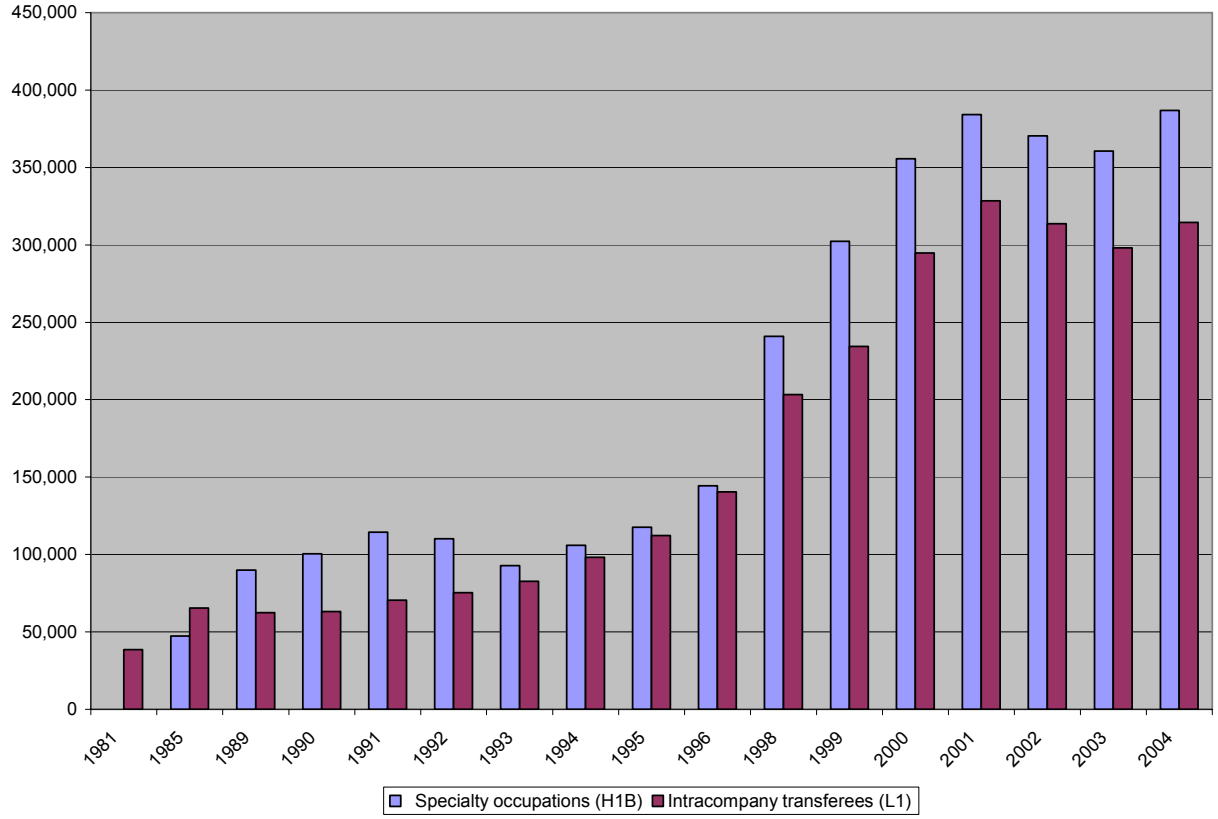
An assessment of the aggregate impact of temporary foreign workers with an H-1B or L-1 visa on the S&E labor market depends on the total number of workers employed in any year, the change in that number each year, and their distribution among specific jobs and occupations nationally. There can also be different local market impacts if these workers are concentrated in specific geographical areas. In these next sections, we examine currently available DHS data (and DOS data on visas issued) to determine whether the data support making such estimates.

[57] Office of Inspector General, *Approval of H-1B Petitions Exceeded Cap in FY2005*, Homeland Security, September 2005, #OIG-05-49; Wasem, Ruth Ellen, *Immigration: Legislative Issues on Non-immigrant Professional Specialty (H-1B) Workers*, Congressional Research Service, RL30498, February 12, 2004.

H-1B and L-1 Visa Admittances

Chart 3-1 shows the number of temporary workers with H-1B and L-1 Visa admitted to the U.S. by fiscal year based on DHS arrival and departure (I-94) data.

Chart 3-1
Non-Immigrants Admitted by Visa Class
Selected Fiscal Years 1981-2004



The numbers of H-1B and L-1 visits should increase and decrease with changes in the number of temporary workers in the U.S. and the frequency of their foreign travel. The number of workers is likely to respond to the aggregate growth and decline in the economy, if these programs are functioning as intended to relieve specific S&E shortages. The growth in H-1B and L-1 arrivals shown in Chart 3-1 from 1981 through 2004[58] includes both new applicants and returns by currently employed temporary workers who had made an overseas visit during the year. From

[58] Chart created by NAPA staff from data on the US Citizenship and Immigration Services website, <www.uscis.gov>, on 5/19/06. The following relevant notes were attached to the USCIS tables <http://www.uscis.gov/graphics/shared/statistics/yearbook/YrBk04TA.htm>: "Prior to October 1, 1991 (fiscal year 1992), H1B admissions were termed 'Distinguished merit or ability.'"; "No reliable data available for 1997."; "Data for fiscal year 1991, 1992, and 1993 differ from data published in previous Yearbooks due to corrections in the underreporting of student entries and more minor adjustments to entries for other classes of non-immigrant admission."

1997 to 2001, arrivals grew substantially, likely mirroring the expansion in the number of temporary foreign workers hired to accommodate the dot.com and IT boom. In 2002 and 2003, these arrivals fell as some workers may have left (and not returned) or the frequency of foreign travel declined because of the dot.com bust, September 11, and economic recession. In 2004, arrivals grew again responding to economic recovery that may have stimulated both an increased travel frequency and an increase in the number of new temporary workers employed.

If the number of foreign trips per year per H-1B and L-1 temporary worker were known and relatively stable, the admissions data reflected in Chart 3-1 might be a reasonable proxy for the inventory of temporary workers in the U.S. over time. However, DHS staff have suggested that their own analysis of mean lengths of stay[59] for various migrants (including temporary workers) indicated that these varied significantly both among categories of migrants and over time. Consequently, the admissions data appear to be an uncertain proxy for the number of temporary workers (the inventory of those workers) annually employed in the U.S.

New Visas Issued

Examining the number of new H-1B and L-1 visas issued by the Consular Services within the Department of State in any year can provide a way of distinguishing the number of these trips by new temporary workers from returning admissions by traveling temporary workers. In 2004, the United States issued new visas for 138,958 temporary workers under the H-1B program, and another 62,700 under the L-1 program (see Table 3-2). These numbers declined in FY 2005 to 124,100 for H-1B workers, but increased slightly to 65,458 for L-1 workers.

Table 3-2
Temporary Visas issued in Categories Likely to include Scientists and Engineers (FY 2004)[60]

Visa type	Category	Number
Work		
H-1B	Specialty occupations requiring BA degree	138,958
L-1	Intra-company transfers	62,700
O-1	People of extraordinary ability	6,437
O-2	Workers assisting O-1	2,611
Student/exchange		
F-1	Students	218,898
J-1	Exchange visitors	254,504

In the L-1 category—*Specialized Knowledge*—about one-fourth of visas applications in 2002 came from Canadian firms, with another 12 percent from Japan and 10 percent from India. In

[59] Elizabeth M. Grieco, *Estimates of the Non immigrant Population in the United States: 2004*. DHS, OIS, June 2006.
[60] U.S. Department of State, Immigrant Visa Control and Reporting Division, administrative data. Science and Engineering Indicators 2006.

2005, Indian firms received 48 percent of visa and Canadians only 15 percent. In general, most of the rest of the visas awarded were spread across a wide number of countries.

Table 3-3 compares the number of new visas issued (DOS data) with the number of admissions for H-1B and L-1 temporary workers in from FY2001 to FY2005. As expected, the number of annual admissions substantially exceeds the number of new visas issued for both temporary worker programs. Moreover, although the number of admissions per visa declined steadily for L-1 visas, there was no similar relationship for H-1B visas. As DOS consular staff have noted, not all visas issued in a given fiscal year are used by the recipient to enter the U.S. in that year. Since the DHS data reflect admissions for all H-1B and L-1 workers, and not simply those with newly awarded visas, the linkage between these two different indicators is conceptually blurred. The inability to link the data electronically to identify how many admissions result from new visa holders adds to this difficulty. There is no common identifier in either the DOS or DHS data for individual H-1B or L-1 temporary workers except for name and date of birth. Both DOS and DHS staff indicated that they were unaware of any attempt to link these data.

Table 3-3
Comparison of Temporary H-1B and L-1 Visas and Admittances[61]
(in 000's)

Fiscal Year	2001	2002	2003	2004	2005
H-1B					
Visas Issued	161.6	118.4	107.2	139	124.1
Admittances	384.2	370.5	360.5	386.8	407.4
Admit/Visa (In Units)	2.4	3.1	3.4	2.8	3.3
L-1					
Visas Issued	59.4	57.7	57.2	62.7	65.5
Admittances	328.5	313.7	298.1	314.5	312.1
Admit/Visa (In Units)	5.5	5.4	5.2	5.0	4.8

Petitions Approved

Petitions filed annually by businesses for H-1B and L-1 temporary workers provide an alternative source for estimating the number of these workers actually employed in the U.S. The principal data problems are:

- There are duplicative petitions that cannot be identified and separated from the annual estimates.

- It is unclear how long approved temporary workers remain in the job for which they have been approved.

[61] Sources: Visa data are from Dept of State, Bureau of Consular Affairs, 2005 Report of the Visa Office, Table XVI(B); Admittance data are from DHS, Office of Immigration Statistics, 2005 Yearbook of Immigration Statistics, Table 26.

- As a recent GAO report indicated, it is not clear that DHS can identify the number of H-1B workers temporarily unemployed since not all employers may be submitting the required notification letter to DHS.[62]

Petition data do contain a wealth of demographic and other information that may provide answers to some of the other key questions raised, however.

Table 3-4
H-1B Petitions Filed and/or Approved by Type of Petition:
Fiscal Years 2000 to 2003[63]

	FY 2000	FY 2001	FY 2002	FY 2003
Petitions filed	**299,046**	**342,035**	**215,190**	**231,030**
Initial Employment	164,814	201,543	109,576	108,526
Continuing Employment	134,232	140,492	105,614	122,504
Petitions approved[1]	**257,640**	**331,206**	**197,537**	**217,340**
Initial Employment	136,787	201,079	103,584	105,314
Continuing Employment	120,853	130,127	93,953	112,026

[1] Regardless of when filed.

Few H-1B petitions filed are turned down. Table 3-4 shows the number of H-1B visa applications filed and approved for initial and continuing employment, for 2000 to 2003. In 2000, 86.2 percent were accepted, followed by 96.8 percent in 2001, 91.8 percent in 2002, and 94.1 percent in 2003.

[62] GAO, *H-1B Foreign Workers: Better Tracking Needed to Help Determine H-1B Program's Effects on U.S. Workforce,* GAO 03-883, September 2003. pp 29-30.
[63] Accessed on 5/19/06: <http://www.uscis.gov/graphics/aboutus/repsstudies/h1b/FY03H1BFnlCharRprt.pdf>

Table 3-5
H-1B Petitions Approved by Type: Fiscal Years 2000 to 2003[64]

Type of Petition	Petitions Approved							
	FY 2000[1]	Percent	FY 2001	Percent	FY 2002	Percent	FY 2003	Percent
Total	**257,640**	**100**	**331,206**	**100**	**197,537**	**100**	**217,340**	**100**
Initial employment	**136,787**	**53**	**201,079**	**61**	**103,584**	**52**	**105,314**	**48**
Aliens outside U.S.	75,785	29	115,759	35	36,494	18	41,895	19
Aliens in U.S.	61,002	24	85,320	26	67,090	34	63,419	29
Continuing employment	**120,820**	**47**	**130,127**	**39**	**93,953**	**48**	**112,026**	**52**

Table 3-5 shows the number of applications approved for H-1B visas for foreigners living in the United States and those living abroad. A substantial number of H-1B visa applicants are already in the country. The percentage of approved H-1B visa petitions for applicants already in the country grew substantially over the last two years. In 2000 and 2001, foreign applicants outside the United States comprised 29 percent and 35 percent of the total H-1B approvals, respectively. By 2002 and 2003, that percentage had fallen to 18 percent and 19 percent, respectively. Others support these findings. According to a study by the Center for Immigration Studies, 60 percent of H-1B visa recipients were already in the United States either on a different temporary visa or illegally.[65]

Much of this increase in the use of approved H-1B petitions by foreigners in the U.S. was due to the increase in the share of total petitions accounted for by those seeking continuing employment. This increase in petitions for continuing employment may have occurred for two reasons: (1) Temporary foreign S&E workers attracted to fill dot.com positions were laid off during the dot.com bust, only to be rehired as the economy began to recover. Some of them had the wherewithal to remain in the United States until they could be rehired and were able to do so given uncertainty about their whereabouts and actual status. (2) Students attracted to the United States under the dot.com boom were just graduating as the economy began to recover. Having completed their training, they were absorbed into the job market as H-1B visa workers.

[64] In fiscal year 2000, type was missing on 33 approved petitions.
Shaded cells represent the petitions approved in either fiscal year 2000, 2001, 2002 or 2003 that qualified as counting towards the numerical limit of 195,000 based on rules existing prior to the enactment of AC21 and before adjustments for multiple petitions and revocations.
http://www.uscis.gov/graphics/aboutus/repsstudies/h1b/FY03H1BFnlCharRprt.pdf
[65] Miano 2005: 10.

Table 3-6
H-1B Petitions Approved by Country of Birth of Beneficiary and Type of Petition (Number): Fiscal Years 2002 and 2003[66]

Country of Birth	All Beneficiaries		Initial Employment		Continuing Employment	
	FY 2002 Number	FY 2003 Number	FY 2002 Number	FY 2003 Number	FY 2002 Number	FY 2003 Number
Total	**197,537**	**217,340**	**103,584**	**105,314**	**93,953**	**112,026**
Country of birth known	**197,092**	**217,031**	**103,350**	**105,185**	**93,742**	**111,846**
India	64,980	79,166	21,066	29,269	43,914	49,897
China, People's Republic	18,841	20,063	11,832	11,144	7,009	8,919
Canada	11,760	11,160	7,893	6,201	3,867	4,959
Philippines	9,295	10,454	6,648	6,852	2,647	3,602
United Kingdom	7,171	7,599	4,192	3,871	2,979	3,728
Korea	5,941	6,614	3,886	3,893	2,055	2,721
Japan	4,937	5,716	2,970	3,287	1,967	2,429
Taiwan	4,025	4,076	2,366	2,109	1,659	1,967
Pakistan	3,810	3,549	1,955	1,501	1,855	2,048
Germany	3,291	3,408	1,955	1,788	1,336	1,620
Mexico	3,082	3,407	1,905	1,969	1,177	1,438
France	3,145	3,190	1,925	1,621	1,220	1,569
Colombia	3,320	3,125	2,362	1,771	958	1,354
Russia	2,864	2,905	1,523	1,265	1,341	1,640
Venezuela	2,398	2,677	1,610	1,798	788	879
Brazil	2,287	2,354	1,414	1,307	873	1,047
Turkey	2,004	2,305	1,319	1,311	685	994
Argentina	2,148	2,230	1,611	1,479	537	751
Australia	1,846	1,925	1,107	986	739	939
Israel	1,620	1,841	1,042	1,085	578	756
Other countries	38,327	39,267	22,769	20,678	15,558	18,589
Country of birth unknown	**445**	**309**	**234**	**129**	**211**	**180**

Indians predominate among H-1B visa holders, particularly among those seeking initial employment. Table 3-6 shows the country of birth of all proposed beneficiaries of H-1B visa petitions approved—both those in initial employment and those under continuations. There is a perception that nearly all these H-1B beneficiaries are from India, but these data in Table 3-6 indicate that that perception is not entirely accurate. In 2002 and 2003, Indians accounted for 33.0 percent and 36.5 percent, respectively, of all H-1B visa holders. But the nearest rival to India was the Chinese at 9.6 percent and 9.2 percent, for 2002 and 2003, respectively. Moreover, the same top eight countries accounted for between 64 percent and 67 percent of all H-1B beneficiaries. Visas were spread fairly widely among a number of different countries. Further, when only looking at initial employment under H-1B, Indians are less well represented at 20.4 percent and 27.8 percent, respectively, for 2002 and 2003. But for continuing employment, Indians dominated H-1B visa holders at 46.8 percent and 44.6 percent, for 2002 and 2003, respectively.

[66] Notes: Countries of birth are ranked based on 2003 data.
<http://www.uscis.gov/graphics/aboutus/repsstudies/h1b/FY03H1BFnlCharRprt.pdf>

Table 3-7
H-1B Petitions Approved by Country of Birth of Beneficiary and Type of Petition (Percent): Fiscal Years 2002 and 2003[67]

Country of Birth	All Beneficiaries		Initial Employment		Continuing Employment	
	FY 2002 Percent	FY 2003 Percent	FY 2002 Percent	FY 2003 Percent	FY 2002 Percent	FY 2003 Percent
Total	------	------	------	------	------	------
Country of birth known	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
India	33.0	36.5	20.4	27.8	46.8	44.6
China, People's Republic	9.6	9.2	11.4	10.6	7.5	8.0
Canada	6.0	5.1	7.6	5.9	4.1	4.4
Philippines	4.7	4.8	6.4	6.5	2.8	3.2
United Kingdom	3.6	3.5	4.1	3.7	3.2	3.3
Korea	3.0	3.0	3.8	3.7	2.2	2.4
Japan	2.5	2.6	2.9	3.1	2.1	2.2
Taiwan	2.0	1.9	2.3	2.0	1.8	1.8
Pakistan	1.9	1.6	1.9	1.4	2.0	1.8
Germany	1.7	1.6	1.9	1.7	1.4	1.4
Mexico	1.6	1.6	1.8	1.9	1.3	1.3
France	1.6	1.5	1.9	1.5	1.3	1.4
Colombia	1.7	1.4	2.3	1.7	1.0	1.2
Russia	1.5	1.3	1.5	1.2	1.4	1.5
Venezuela	1.2	1.2	1.6	1.7	0.8	0.8
Brazil	1.2	1.1	1.4	1.2	0.9	0.9
Turkey	1.0	1.1	1.3	1.2	0.7	0.9
Argentina	1.1	1.0	1.6	1.4	0.6	0.7
Australia	0.9	0.9	1.1	0.9	0.8	0.8
Israel	0.8	0.8	1.0	1.0	0.6	0.7
Other countries	19.4	18.1	22.0	19.7	16.6	16.6
Country of birth unknown	------	------	------	------	------	------

[67] Notes: Countries of birth are ranked based on 2003 data. Percents shown in the table are based on the total number of petitions approved with country of birth known.
<http://www.uscis.gov/graphics/aboutus/repsstudies/h1b/FY03H1BFnlCharRprt.pdf>

Table 3-8
H-1B Petitions Approved by Age of Beneficiary at Time of Approval and by Type of Petition: Fiscal Year 2003[68]

Age	Total	Percent	Initial Employment	Percent	Continuing Employment	Percent
Total	**217,340**	------	**105,314**	------	**112,026**	------
Age known	**217,114**	**100.0**	**105,194**	**100.0**	**111,920**	**100.0**
Under 20	168	0.1	162	0.2	6	0.0
20-24	14,202	6.5	12,395	11.8	1,807	1.6
25-29	75,222	34.6	37,841	36.0	37,381	33.4
30-34	66,954	30.8	27,341	26.0	39,613	35.4
35-39	33,231	15.3	13,928	13.2	19,303	17.2
40-44	15,151	7.0	7,021	6.7	8,130	7.3
45-49	6,832	3.1	3,521	3.3	3,311	3.0
50-54	3,159	1.5	1,715	1.6	1,444	1.3
55-59	1,450	0.7	849	0.8	601	0.5
60-64	541	0.2	309	0.3	232	0.2
65 and over	204	0.1	112	0.1	92	0.1
Age unknown	226	------	120	------	106	------

H-1B visas attract a relatively young and inexperienced workforce, suggesting that the type of work they are performing tends to be more entry level. Table 3-8 shows the age of H-1B visa holders, controlling for initial and continuing employment. In 2003, 41.2 percent of workers were less than 30 years of age. Nearly three-fourths (72.0 percent) were less than 40 years old. Younger (less than 40) workers predominated in both initial and continuing employment categories at 74.0 percent and 70.4 percent, respectively. While this may reflect the type of work these temporary workers are being hired to perform, some program critics believe employers are able to reduce their costs because they pay younger workers less. Others believe younger workers are better trained in the skills currently needed by industry.

[68] Notes: Age of beneficiary is calculated based on the date the petition was approved.
Percentages shown in the table are based on the total number of approved petitions with known ages.
<http://www.uscis.gov/graphics/aboutus/repsstudies/h1b/FY03H1BFnlCharRprt.pdf>

Table 3-9
H-1B Petitions Approved by Level of Education of Beneficiary and Type of Petition: Fiscal Year 2003[69]

Level of Education	Total	Percent	Initial Employment	Percent	Continuing Employment	Percent
Total	**217,340**	-------	**105,314**	-------	**112,026**	-------
Education known	**217,157**	**100.0**	**105,221**	**100.0**	**111,936**	**100.0**
No high school diploma	223	0.1	148	0.1	75	0.1
High school graduate	1,027	0.5	822	0.8	205	0.2
Less than 1 year of college credit	204	0.1	122	0.1	82	0.1
1 or more years of college credit, no diploma	1,096	0.5	623	0.6	473	0.4
Associate's degree	962	0.4	534	0.5	428	0.4
Bachelor's degree	107,944	49.7	51,141	48.6	56,803	50.7
Master's degree	66,672	30.7	30,612	29.1	36,060	32.2
Doctorate degree	26,565	12.2	14,448	13.7	12,117	10.8
Professional degree	12,464	5.7	6,771	6.4	5,693	5.1
Education unknown	**183**	-------	**93**	-------	**90**	-------

Although the preponderance of H-1B visa holders have not attended graduate school, over 98 percent had at least a bachelor's degree. Table 3-9 reveals the educational status of H-1B visa holders for 2003. A perception about H-1B is that it targets graduate-degreed workers, especially doctorates. Some 42.9 percent of visa holders had graduate degrees, either masters (30.7 percent) or doctoral (12.2 percent). But a larger share of workers held only baccalaureate degrees at 49.7 percent. This was the case for both initial and continuing employment visa holders.

Most of the H-1B petitions appear to be granted to firms in S&E related industries as the program intended. Tables 3-10 and 3-11 present the number and percent of industries with firms having approved H-1B visa petitions for 2002 and 2003. The top five industries, including universities and colleges, were S&E-related and accounted for over half of the approved petitions. The range of industries with firms holding approved H1-B petitions suggests that this is not necessarily the "computer programmer" visa program, as some critics have asserted. Despite this range, most of the industries with approved petitions also appear to be S&E-related industries. Although data suggest that the H-1B visa program is obtaining high-skilled temporary foreign workers for S&E related industries, it is also possible this distribution reflects the effect of the H-1B caps and exemptions from them. Thus, one effect of the H-1B caps is to cause H-1B temporary worker to be more heavily concentrated in educational and non-profit sectors, exempt from caps.

[69] Percents shown in the table are based on the number of approved petitions with known levels of education. <http://www.uscis.gov/graphics/aboutus/repsstudies/h1b/FY03H1BFnlCharRprt.pdf>

Table 3-10
H-1B Petitions Approved by Detailed Industry and Type of Petition (Number): Fiscal Years 2002 and 2003[70]

Industry NAICS Code (4-digits)	All Beneficiaries FY 2002 Number	 FY 2003 Number	Initial Employment FY 2002 Number	 FY 2003 Number	Continuing Employment FY 2002 Number	 FY 2003 Number
Total	**197,537**	**217,340**	**103,584**	**105,314**	**93,953**	**112,026**
Industry known	**179,757**	**198,407**	**93,227**	**94,615**	**86,530**	**103,792**
Computer systems design & related services (5415)	50,776	56,872	16,714	19,347	34,062	37,525
Colleges, universities, & professional schools (6113)	18,401	21,956	11,989	13,116	6,412	8,840
Architectural, engineering, & related services (5413)	8,963	8,969	5,407	4,589	3,556	4,380
Management, scientific, & technical consulting services (5416)	7,458	8,612	4,081	5,023	3,377	3,589
Scientific research and development services (5417)	6,695	7,119	4,187	3,818	2,508	3,301
Elementary and secondary schools (6111)	3,983	4,992	3,034	3,413	949	1,579
General medical and surgical hospitals (6221)	3,442	4,042	2,009	2,171	1,433	1,871
Telecommunications (5133)	4,357	3,807	1,798	1,022	2,559	2,785
Accounting, tax preparation, bookkeeping, & payroll services (5412)	3,507	3,759	2,161	2,160	1,346	1,599
Semiconductor & other electronic component manufacturing (3344)	2,891	3,636	1,396	1,084	1,495	2,552
Securities & commodity contracts intermediation & brokerage (5231)	2,917	3,100	1,589	1,294	1,328	1,806
Offices of physicians (6211)	2,475	3,019	1,271	1,596	1,204	1,423
Other professional, scientific, & technical services (5419)	1,929	1,916	1,226	1,109	703	807
Professional, scientific, and technical services (5410)	1,799	1,888	956	845	843	1,043
Offices of other health practitioners (6213)	1,430	1,871	933	1,145	497	726
Communications equipment manufacturing (3342)	1,688	1,856	721	353	967	1,503
Other financial investment activities (5239)	1,785	1,788	1,099	923	686	865
Computer and peripheral equipment manufacturing (3341)	1,612	1,692	814	470	798	1,222
Specialized design services (5414)	1,417	1,551	874	904	543	647
Employment services (5613)	1,245	1,508	747	788	498	720
Legal Services (5411)	1,429	1,479	976	882	453	597
Pharmaceutical and medicine manufacturing (3254)	1,633	1,477	934	703	699	774
Software publishers (5112)	1,165	1,319	476	355	689	964
Computer and electronic product manufacturing (3340)	1,207	1,315	480	346	727	969
Information services (5141)	1,676	1,292	613	458	1,063	834
Advertising and related services (5418)	1,104	1,218	668	663	436	663
Other industries	42,773	46,354	26,074	26,038	16,699	20,208
Industry unknown	**17,780**	**18,933**	**10,357**	**10,699**	**7,423**	**8,234**

[70] Notes: Industries ranked by total beneficiaries in 2003.
<http://www.uscis.gov/graphics/aboutus/repsstudies/h1b/FY03H1BFnlCharRprt.pdf>

Table 3-11
H-1B Petitions Approved by Detailed Industry and Type of Petition (Percent)
Fiscal Years 2002 and 2003[71]

Industry NAICS Code (4-digits)	All Beneficiaries FY 2002 Percent	All Beneficiaries FY 2003 Percent	Initial Employment FY 2002 Percent	Initial Employment FY 2003 Percent	Continuing Employment FY 2002 Percent	Continuing Employment FY 2003 Percent
Total	------	------	------	------	------	------
Industry known	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Computer systems design & related services (5415)	28.2	28.7	17.9	20.4	39.4	36.2
Colleges, universities, & professional schools (6113)	10.2	11.1	12.9	13.9	7.4	8.5
Architectural, engineering, & related services (5413)	5.0	4.5	5.8	4.9	4.1	4.2
Management, scientific, & technical consulting services (5416)	4.1	4.3	4.4	5.3	3.9	3.5
Scientific research and development services (5417)	3.7	3.6	4.5	4.0	2.9	3.2
Elementary and secondary schools (6111)	2.2	2.5	3.3	3.6	1.1	1.5
General medical and surgical hospitals (6221)	1.9	2.0	2.2	2.3	1.7	1.8
Telecommunications (5133)	2.4	1.9	1.9	1.1	3.0	2.7
Accounting, tax preparation, bookkeeping, & payroll services (5412)	2.0	1.9	2.3	2.3	1.6	1.5
Semiconductor & other electronic component manufacturing (3344)	1.6	1.8	1.5	1.1	1.7	2.5
Securities & commodity contracts intermediation & brokerage (5231)	1.6	1.6	1.7	1.4	1.5	1.7
Offices of physicians (6211)	1.4	1.5	1.4	1.7	1.4	1.4
Other professional, scientific, & technical services (5419)	1.1	1.0	1.3	1.2	0.8	0.8
Professional, scientific, and technical services (5410)	1.0	1.0	1.0	0.9	1.0	1.0
Offices of other health practitioners (6213)	0.8	0.9	1.0	1.2	0.6	0.7
Communications equipment manufacturing (3342)	0.9	0.9	0.8	0.4	1.1	1.4
Other financial investment activities (5239)	1.0	0.9	1.2	1.0	0.8	0.8
Computer and peripheral equipment manufacturing (3341)	0.9	0.9	0.9	0.5	0.9	1.2
Specialized design services (5414)	0.8	0.8	0.9	1.0	0.6	0.6
Employment services (5613)	0.7	0.8	0.8	0.8	0.6	0.7
Legal Services (5411)	0.8	0.7	1.0	0.9	0.5	0.6
Pharmaceutical and medicine manufacturing (3254)	0.9	0.7	1.0	0.7	0.8	0.7
Software publishers (5112)	0.6	0.7	0.5	0.4	0.8	0.9
Computer and electronic product manufacturing (3340)	0.7	0.7	0.5	0.4	0.8	0.9
Information services (5141)	0.9	0.7	0.7	0.5	1.2	0.8
Advertising and related services (5418)	0.6	0.6	0.7	0.7	0.5	0.6
Other industries	23.8	23.4	28.0	27.5	19.3	19.5
Industry unknown	------	------	------	------	------	------

[71] Notes: Industries ranked by total beneficiaries in 2003. Percents shown are based on the total number of petitions approved with industry known.
<http://www.uscis.gov/graphics/aboutus/repsstudies/h1b/FY03H1BFnlCharRprt.pdf>

Wages Paid Temporary Foreign Workers

Perhaps the most controversial issue surrounding the use of temporary foreign workers with H-1B and L-1 visas is whether they receive less compensation than U.S. citizens. Although the Foreign Labor Certification program within the Employment and Training Administration (ETA) at the Department of Labor (DOL) reviews petitions and the proposed wages contained in them to assure that they meet prevailing market wages for the occupation and locality, program critics continue to claim that industries use the program to obtain cheaper labor, rather than filling worker shortages.

Table 3-12 contains median annual salary of workers in S&E occupations from NSF and compares these median annual S&E salaries for temporary residents relative to all workers for selected years from 1993 to 2003. The median overall S&E salary for 2003 was $66,000, while the median for temporary residents was only $60,000. Since 1993, the median annual salary for temporary residents has been less than the aggregate median. However, NSF data indicate that median salaries vary by ethnic and gender groups, by age and by location. Other factors affecting median annual salaries must be accounted for in evaluating differences between non-resident and resident S&E salaries. In short, a simple comparison of these medians is not sufficient to support the claim that H-1B and L-1 workers have earned less than all workers in S&E.[72]

Table 3-12
Median Annual Salary (US dollars) of Individuals Employed in S&E Occupations, by Sex, Race/Ethnicity, and Visa Status (Selected years, 1993–2003) [73]

Sex/Race/Ethnicity	1993	1995	1997	1999	2003
S&E employed	48,000	50,000	55,000	60,000	66,000
Male	50,000	52,000	58,000	64,000	70,000
Female	40,000	42,000	47,000	50,000	53,000
White	48,000	50,500	55,000	61,000	67,000
Asian/Pacific Islander	48,000	50,000	55,000	62,000	70,000
Black	40,000	45,000	48,000	53,000	58,000
Hispanic	43,000	47,000	50,000	55,000	60,000
Temporary residents	43,300	49,700	49,000	52,000	60,000

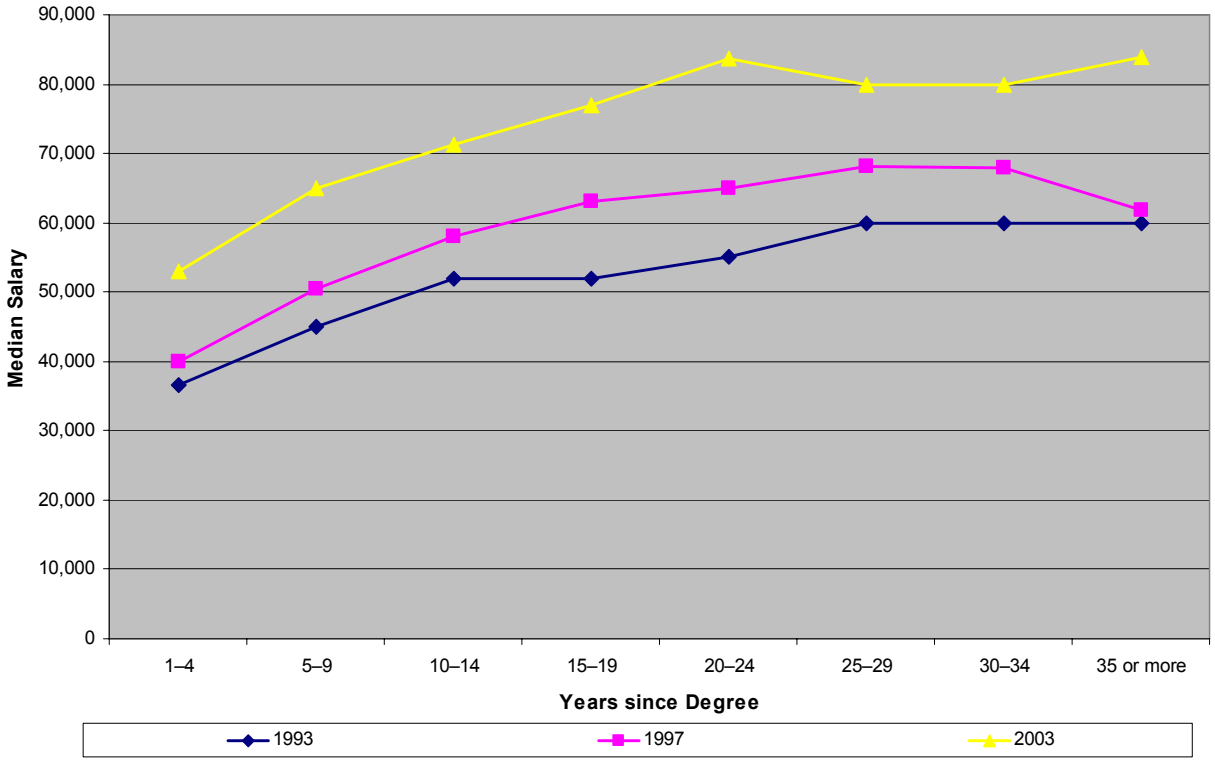
As noted, H-1B workers tend to be a relatively younger. Chart 3-2 illustrates the difference in median wages for a particular S&E occupation at a given degree level for different years of experience. This age/earnings curve for engineers with a bachelors degree demonstrates that earnings increase with age/experience up to a certain point and this phenomenon holds fairly consistently over time and for all S&E careers, although the peaks and slopes of individual

[72] NSF, Table 3-8, SESTAT source.
[73] NOTE: 2003 data includes some individuals with multiple races in each category. SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (1993–1999) and preliminary estimates (2003), http://sestat.nsf.gov. Science and Engineering Indicators 2006.

curves will vary. In addition to controlling for age/experience differences, any relative wage comparison must also control for differences in university degree and type of industry. Again, as noted earlier, one potential impact of the H-1B caps is that these temporary foreign workers may be more heavily concentrated in academe and the non-profit sector, where historically wages have been lower than those paid in for profit businesses.

According to a study by the Center for Immigration Studies comparing H-1B wages in 2004 with computer programming wages from BLS's Occupational Employment Statistics (OES) program, H-1B workers were paid significantly less than U.S. workers. In addition, H-1B workers were clustered more in lower paying wage categories than were U.S. computer programmers; suggesting that H-1B visas were being used to pay lower wages than to address shortages in specific high-skill occupations.[74] But again, these comparisons do not fully control for all the factors explaining differences in S&E salaries.

Chart 3-2
Median Salaries for U.S. Individuals in Engineer Occupations
(1993, 1997 and 2003), Bachelors Degree



[74] Miano, John, "The Bottom of the Pay Scale: Wages for H-1B Computer Programmers," Washington, DC: Center for Immigration Studies, December 2005, table Appendix A, page 21.

Table 3-13
H-1B Computer Programming Wages Compared to National Wages by Occupation F.Y. 2004
National Wages OES. 2003[75]

	H-1B Wages			H-1B Wages Compared to Expected OES Wages				Distribution of H-1B Wages					
Occupation	Min	Max	Mean	OES Mean	Difference	OES Median	Difference	0-9	10-24	25-49	50-74	75-89	90-99
Computer scientists	$20,800	$188,800	$78,169	$90,146	($11,977)	$85,017	($6,847)	13%	22%	30%	24%	9%	2%
Programmers	$16,796	$260,000	$49,258	$65,264	($16,006)	$62,577	($13,319)	7%	47%	34%	9%	2%	0%
Software Engineers	$16,872	$228,800	$62,179	$77,954	($15,775)	$74,851	($12,672)	17%	40%	22%	15%	5%	1%
Support Specialists	$19,968	$113,000	$44,321	$44,823	($502)	$41,559	$2,762	3%	21%	34%	17%	13%	12%
Systems Analysts	$18,720	$218,400	$53,150	$66,722	($13,573)	$64,446	($11,297)	12%	42%	32%	9%	5%	1%
Database administrators	$26,440	$200,000	$58,338	$61,696	($3,358)	$58,702	($364)	7%	25%	24%	26%	14%	5%
Systems administrators	$26,400	$144,000	$45,481	$62,958	($17,478)	$60,406	($14,925)	48%	22%	12%	10%	6%	3%
Network Analysts	$19,200	$150,000	$55,358	$64,799	($9,441)	$61,607	($6,248)	2%	21%	57%	16%	3%	1%

[75] http://www.cis.org/articles/2005/back1305appendices.pdf

An increase in the supply of skilled labor from a supply shift due to immigration should result in an increase in employment and a reduction in wages given a normal, downward sloping demand curve. Literature on the impact of highly-skilled immigrant workers on American workers produces mixed results depending upon the impact examined. A study by the Committee for Economic Development noted that high-skilled workers work in high value-added sectors of the economy, fill a critical need and help to put the nation on the "cutting edge" by producing new technologies, products and exports.[76] Another study by Zavodny concluded that H-1B visas had no apparent effect on unemployment rates.[77]

An additional study by George Borjas, using the NSF's Survey of Earned Doctorates and Survey of Doctoral Recipients datasets, found that "increases in the number of foreign-born doctorates, primarily through foreign student programs, had a significant adverse effect on the earnings of competing workers, regardless of whether the competing workers were native-born or foreign-born. An immigration-induced 10 percent increase in the supply of doctorates in a particular field at a particular time reduces the earnings of that cohort of doctorates by 3 percent."[78] These results are not necessarily inconsistent with expected theory, since a shift in supply can increase employment (having no effect on unemployment rates) and reduce wages.

In their 2003 report, GAO noted that DOL's "Wage and Hour division (WHD), which is responsible for ensuring that H-1B workers are receiving legally required wages, has continued to find instances of program abuse."[79] As Table 3-14, reproduced from that report shows, the number of violations doubled from 2000 to 2002.[80] But as GAO indicated, the increase "may be due to the increase in the number of H-1B workers who have entered the country over the years and does not necessarily indicate an increase in the percentage of H-1B workers affected by wage violations."[81] Without more definitive estimates of the total numbers of H-1B and L-1 workers employed in the U.S. and the specific jobs they occupy, it is difficult to reach any firm conclusion about whether these temporary workers are being exploited and paid lower wages than comparable American workers or how much the H-1B program has shifted supplies thus affecting aggregate employment and wages.

[76] "Reforming Immigration: Helping Meet America's Need for a Skilled Workforce." Statement by the Research and Policy Committee of the Committee for Economic Development, 2001, p. 12.
[77] Zavodny Madeline. "The H-1B Program and its Effects on Information Technology Workers," Federal Reserve Bank of Atlanta, p. 7.
[78] Borjas, George J. "The Labor Market Impact of High-Skill Immigration," Cambridge, MA: National Bureau of Economic Research, March 2005, p. 8.
[79] Op.cit., GAO 2003, p. 25.
[80] Ibid., p. 26.
[81] Ibid., p. 26.

Table 3-14
Department of Labor H-1B Investigations, Violations Identified, and Back Wages Due

Fiscal Year	Investigations Finalized	Number of Investigations Showing Violation	Investigations Showing a Violation as a Percentage of Total Investigations Finalized	Investigations Where Back Wages Found Due	Amount of Back Wages Found Due	Number of Employees Due Back Wages
2000	58	51	88%	49	$1,629,173	339
2001	60	54	90%	48	$1,335,147	198
2002	134	112	84%	94	$4,211,209	580
2003 (Thru 3-03)	71	62	87%	56	$2,126,881	478

CONCLUSIONS

In its 2003 report, GAO concluded that, "much of the information policy makers need to effectively oversee the H-1B program is not available because of limitations of DHS's current tracking systems."[82] Unfortunately, the Panel must reaffirm that conclusion. Moreover, GAO cited the information they believed was needed "Examples of needed information include the total number of H-1B workers employed in the United States at a given time and the numbers of H-1B workers employed in various occupations, [and] the extent to which H-1B workers become long-term member of the labor force through permanent residency."[83] The same is true for temporary workers with an L-1 visa.

Thus, the Panel finds that current data deficiencies preclude identifying the number of H-1B and L-1 temporary workers actually employed in the United States in any given year and this basic information is critical to assessing the impact of these programs on the S&E labor market and the need for U.S. firms to off-shore services.

Despite this key data limitation, the DHS petition data do lead to the following conclusions regarding the use of temporary foreign H-1B workers. The Panel finds that:

- The H-1B and L-1 visa programs clearly increase the domestic S&E labor force, and appear to have reduced the need to off-shore high-tech services to meet specific skill needs, even though current data limitations preclude identifying the number of these workers actually employed in the U.S. at any given time.

- The administrative databases were not designed to provide reliable analytical information on S&E labor markets, and do not provide a firm basis for estimating the impact of these programs on the current S&E market.

[82] Ibid., p. 32.
[83] Ibid., p. 32.

- These administrative data do provide some proximate information on the general demographic characteristics of these beneficiaries.

    - The primary beneficiaries of H-1B and L-1 visa programs are workers from India and China, but many other countries contribute as well.
    - Most are younger than the domestic S&E workforce.
    - Contrary to popular belief, most do not hold PhDs or even graduate degrees for that matter.
    - A substantial majority of H-1B beneficiaries were already in the U.S. when they obtained their visa, either as a foreign student, a foreign temporary worker obtaining an extension for an expired visa, or in some other status.
    - They are not primarily computer programmers, but they do work in a variety of computer-related fields, as the programs intended.

- The average salaries for these workers appear to be less than those of white American males in the same occupation, but these differences may reflect differences in age, work experience, and the type of employer between these temporary and other workers.

RECOMMENDATION

Since these temporary high-skilled foreign worker programs appear to have increased the supply of high-skilled workers in the U.S, obviating the need to off-shore high-tech services and this will become increasingly important as competition for these workers intensifies in a more globally integrated economy, the Panel recommends that:

- **The President and Congress remove barriers to accepting high-skilled work in the United States and remaining in the United States to continue that work.**

- **The Department of Homeland Security improve its data systems to provide a more accurate accounting of the number of H-1B and L-1 temporary foreign workers actually employed in the U.S. and address other unanswered key questions about them.**

Establishment of a consistent unique numeric identifier for H-1B, L-1, foreign students and other foreign visitors will provide opportunities to link the current DHS and DOS data sets to begin to identify how many temporary H-1B and L-1 foreign workers are actually employed in the U.S., how many foreign students obtain U.S. employment after graduation, and how many of these temporary foreign workers and students eventually become either permanent residents and/or citizens of the U.S. This information will be especially critical for assessing how well the U.S. higher education system and the S&E labor market respond to the challenges presented by an increasingly competitive global S&E market.

CHAPTER FOUR

ARE U.S. UNIVERSITIES KEEPING PACE WITH THE DEMAND FOR S&E WORKERS?

The rapid dispersion of scientific information and the emergence of new centers of knowledge and technical competence in diverse locations in an increasingly integrated global S&E market have raised concerns about U.S. universities' ability to attract, retain, and train the brightest and best S&E students to meet growing U.S. demands for high-skilled S&E workers. Failure to respond to these educational challenges would provide additional impetus for U.S. firms to off-shore high-tech services. Some observers have already expressed concerns that services off-shoring may be discouraging American students' choice of an S&E career. Over the past twenty years, foreign S&E students have accounted for an increasing share of U.S. graduate degrees in many S&E disciplines. To some, this is a sign of strength, since these foreign students are attracted by the quality of the S&E training available at U.S. institutions and the hope of obtaining a U.S. S&E job at least initially after graduation. To others it may be more problematic, since these foreign students may not only crowd out American students, but may also facilitate services off-shoring by returning home and using their U.S. training to attract new high-tech service operations overseas.

This chapter examines what, if any, effect services off-shoring is having on students choosing of an S&E career and what effect increasing globalization is having on the ability of the U.S. higher education system to meet the economy's need for high-skilled S&E workers. The Panel asked…

- Are America's universities meeting U.S demands for high-skilled S&E workers in an increasingly competitive, globally integrated S&E labor market?

- What are the implications of the increasing reliance on foreign students to meet growing U.S. demands for high-skilled S&E workers, particularly those with advanced degrees?

- What new challenges or opportunities do expanding and improving foreign universities pose to past U.S. leadership in S&E education?

The Panel concluded that…

- U.S. universities continue to meet much of U.S. business demands for high-skilled S&E workers. As such, they appear to be helping to reduce any need or incentive to off-shore high-tech services.

- Critical in meeting the demand for S&E labor is the reliance on foreign students attending American universities. Foreign students do not appear to be displacing large numbers of Americans who would otherwise seek S&E careers. And foreign students not remaining

in the U.S. after graduation may provide valuable linkages[84] to new and expanded economic opportunities for American business in the global economy. For example, their familiarity with and knowledge of various high-tech services used in the U.S. can create a demand for those services if comparable ones are not available in their native country.

- Although visa problems for foreign students after September 11 appear to have abated, the U.S. cannot afford barriers that impede U.S. universities' ability to attract and train the best S&E students from either foreign or domestic sources in a more globalized S&E market. Student enrollments in S&E programs and subsequent career choices should reflect informed economic choices,[85] not decisions constrained by legal, cultural or other considerations.

- Other economies and their higher educations systems—especially India and China—are competing with American universities to supply S&E workforce needs in a more globally integrated market. Maintaining and enhancing qualitative differences for U.S. S&E graduates relative to these emerging foreign graduates will be critical for sustaining any U.S. competitive advantage, since population size differences will ultimately determine relative quantitative production levels.

The Panel recommends that:

- **The President and Congress reexamine policies that limit or impose barriers on foreign students who seek S&E education in the United States, and who wish to remain in the country once their education is completed.**

- **Universities strengthen their capacity to produce S&E graduates in a more competitive global labor market.**

- **The Department of Homeland Security modify existing administrative data systems and data elements collected to track the subsequent work and residency choices of graduating foreign students.**

S&E DEGREE PRODUCTION IN THE U.S.

American universities continue to increase their output of high-skilled S&E graduates, in the process, making graduates competitive in the global labor market and reducing need to off-shore high tech services to obtain skilled labor. Numbers of students enrolled and degrees awarded in S&E fields at all levels of U.S. tertiary education have increased over the past two decades. The

[84] Economists refer to this as "backward" linkages. Linkages originating in foreign countries to the U.S. are "forward" linkages.

[85] Some argue, however, that many Americans are simply unprepared to matriculate in S&E programs, having been poorly educated and motivated in elementary and high school venues. If this is the case, and it may well be, given the poor rankings America enjoys on comparisons with other countries in science and math achievement, then the entire education system might require overhaul. This issue has been well-studied, but is beyond the charge of the Panel.

increase among American students occurred even as the U.S. population aged 20 to 24 declined more than 4 percent,[86] indicating that an increased proportion of the American college age population chose an S&E field of study over this period.[87]

The proportion of foreign students pursuing S&E degrees has increased at all levels except the baccalaureate over this same period, likely because there is little funding for foreign student undergraduates from U.S. sources and tuition is rising beyond the reach of many. If off-shoring is a concern, then foreign students must be attracted to and retained in the U.S. economy, as these students have accounted for an increasing share of total U.S. S&E degrees produced beyond the baccalaureate level.

Enrollment in S&E Undergraduate Degrees Has Remained Constant

The proportion of freshmen enrolling in S&E fields and degrees awarded has remained essentially constant over the last 20 years. Although the number of temporary residents receiving S&E undergraduate degrees has increased, growth has been less than the increase for U.S. citizens and permanent residents. Consequently, the proportion of S&E undergraduate degrees awarded foreign students has declined over the last twenty years.

The percent of freshmen intending to major in S&E fields at American universities has held fairly steady over the past two decades. In 1983, 35 percent of freshmen pursued an S&E curriculum, and in 2003, 33 percent did. The biggest dip in that period was in 1987, with 29 percent of freshmen pursuing S&E.[88] However, according to a committee of the National Academies, S&E undergraduate programs report the lowest retention rates of all disciplines, with fewer than half of S&E freshmen completing a degree in those fields throughout the 1990s.[89] Retention has apparently declined somewhat, as the National Science Foundation found that of freshmen majoring in S&E fields in 1987, 56 percent remained in the same or similar major in 1991.[90] Those who switched majors were disproportionately women and students of color, reflecting perhaps a lack of support within the program, rather than attrition in response to diminished job prospects from off-shoring or foreign graduate competition. Those who switched may also have sought other career paths once attending college.

---

[86] Population Projections Program, U.S. Census Bureau, "Projections of the Resident Population by Age, Sex, Race, and Hispanic Origin: 1999 to 2100," Washington, DC: 2000. http://www.census.gov/population/projections/nation/detail/d2001_10.pdf; National Science Board, *Science and Engineering Indicators 2006, Volume 2*, Arlington, VA: National Science Foundation (NSB 06-01A), Table 2-4. http://www.nsf.gov/statistics/seind06/append/c2/at02-04.xls

[87] This was consistent with the overall increase in total American student college participation rates over the past two decades.

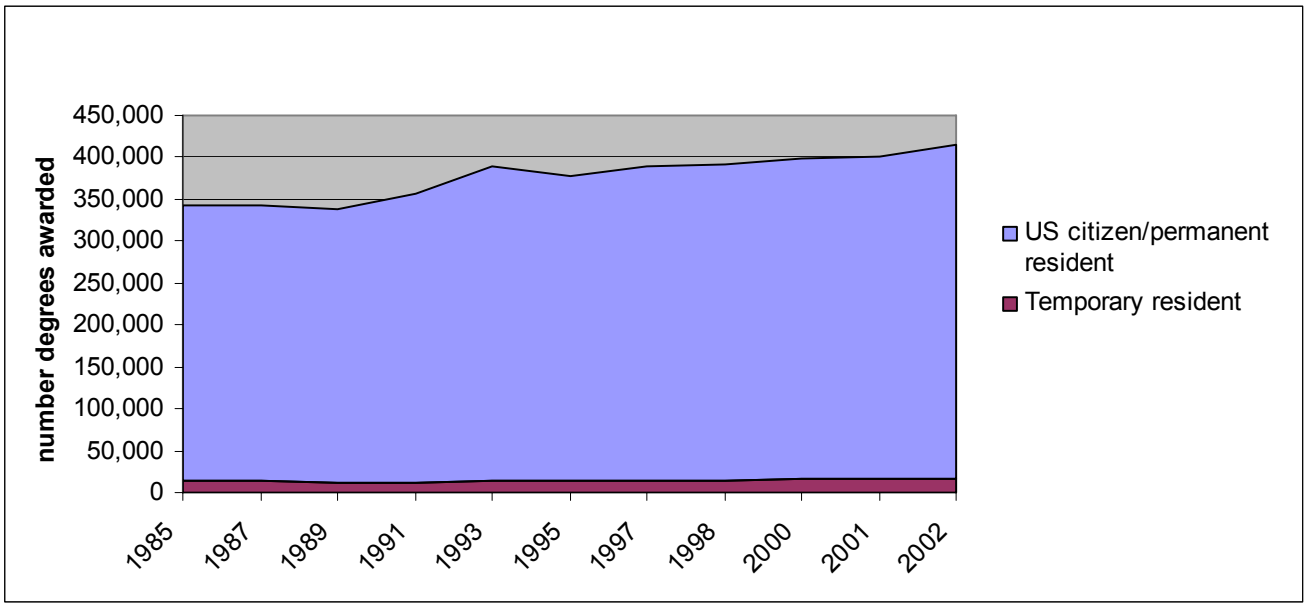
[88] National Science Board, *Science and Engineering Indicators 2006, Volume 2*, Arlington, VA: National Science Foundation (NSB 06-01A), Table 2-6. http://www.nsf.gov/statistics/seind06/append/c2/at02-06.xls

[89] Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology, "Rising Above The Gathering Storm: Energizing and Employing America for a Brighter Economic Future," Washington, DC: National Academy of Sciences, 2006. p 3-27.

[90] Division of Research, Evaluation, and Communication, Directorate for Education and Human Resources, *Indicators of Science and Mathematics Education 1995*, edited by Larry E. Suter, Arlington, VA: National Science Foundation, 1996 (NSF 96-52), p. 84.

In 2002, 415,611 bachelor's degrees were awarded in S&E in the U.S., a 21 percent increase from 1985. The number of S&E degrees was 32 percent of all degrees in 2002, down slightly from 35 percent in 1985. The number of temporary residents receiving bachelor's degrees in S&E has increased 16 percent over this period, while the number of U.S. citizens and permanent residents receiving these degrees has increased 21 percent.[91] (See Chart 4-1.) This increase in the U.S. citizen and permanent resident share of bachelor's S&E degrees awarded does not support concerns that foreign students are "crowding out" American students in the overall S&E field.

Chart 4-1
Earned Bachelor's Degrees in S&E Fields, 1985-2002



Enrollment in Graduate S&E Degrees Has Increased

Overall, numbers of first-time graduate students in S&E fields, graduates enrolled, and degrees awarded have increased over the last 20 years, with foreign residents a growing share of each group. The number of first-time foreign S&E graduate students declined from 2000 to 2003. But that decline appears to have been temporary, since first-time foreign graduate student S&E enrollments increased for the latest academic year.

The number of first-time, full-time S&E graduate students increased 32 percent since 1983 to 107,842 in 2003. That increase was fairly steady except for a temporary decline in 1995-97 to around 89,000. The number of science students increased 33 percent over the period, and engineering students increased 28 percent.[92]

[91] National Science Board, *Science and Engineering Indicators 2006, Volume 2*, Arlington, VA: National Science Foundation (NSB 06-01A), Table 2-27. http://www.nsf.gov/statistics/seind06/append/c2/at02-27.xls
[92] Ibid., Table 2-13. http://www.nsf.gov/statistics/seind06/append/c2/at02-13.xls

First-time graduate enrollment of foreign students in S&E fields declined from 2000 to 2003. Of the 107,842 first-time S&E graduate students in 2003, 28.9 percent were temporary residents, down from 35.3 percent in 2000. In the field of engineering, in 2003, temporary residents made up 49.6 percent of enrollments, substantially down from 2000 when 61.2 percent were enrolled. In science, in 2003, temporary residents accounted for 22.8 percent of enrollments, a small decline from 27.3 percent in 2000.[93]

However, this decline in foreign enrollment seems to have been a temporary trend. Table 4-1 shows the percentage change in enrollments of foreign students for the last couple of academic years based on surveys by the Council of Graduate Schools. First-time enrollment of foreign graduate students increased 12 percent this year (2005/6) over last. In engineering, first-time enrollment was up 22 percent after a 3 percent increase in 2005, and physical and life sciences rose 5 percent and 2 percent, respectively. Chinese and Indian graduate student first-time enrollments led the increase, and were up 20 percent and 32 percent, respectively.[94]

[93] National Science Board, *Science and Engineering Indicators 2006, Volume 2*, Arlington, VA: National Science Foundation (NSB 06-01A), Table 2-16. http://www.nsf.gov/statistics/seind06/append/c2/at02-16.xls

[94] Council of Graduate Schools, "Findings from the 2006 CGS International Graduate Admissions Survey, Phase III: Admissions and Enrollment," Washington, DC: October 2006.

Table 4-1
Percentage Change in International Enrollment, 2004 to 2005 and 2005 to 2006

	First-Time Enrollment, 2004 to 2005	First-Time Enrollment, 2005 to 2006	Total Enrollment, 2004 to 2005	Total Enrollment, 2005 to 2006
International Total	1%	12%	-3%	1%
Country of Origin				
China	3%	20%	-2%	-2%
India	3%	32%	-4%	8%
Korea	5%	5%	-4%	-3%
Middle East*	11%	-1%	1%	1%
Field of Study				
Business	7%	10%	-3%	1%
Education	-15%	8%	-8%	-9%
Engineering	3%	22%	-6%	3%
Humanities and Arts	-2%	-6%	1%	-7%
Life Sciences	-1%	2%	-5%	-1%
Physical Sciences	1%	5%	-1%	-4%
Social Sciences	-2%	3%	-4%	-2%

Sources: 2005 & 2006 CGS International Graduate Admissions Survey III: Admissions and Enrollment.
*Middle East countries include: Bahrain, Cyprus, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestinian Authority, Qatar, Saudi Arabia, Syria, Turkey, United Arab Emirates, Yemen

In overall S&E graduate enrollments, foreign students accounted for 27 percent in 2003, a substantial increase from 19 percent in 1983. Although their share declined, the number of U.S. citizens and permanent residents enrolled in S&E fields climbed steadily, except for a slight drop off during the late 90s. Foreign graduate enrollments also declined in 1995 and then leveled off, but have increased steadily since 1999.[95] (See Charts 4-2 and 4-3.)

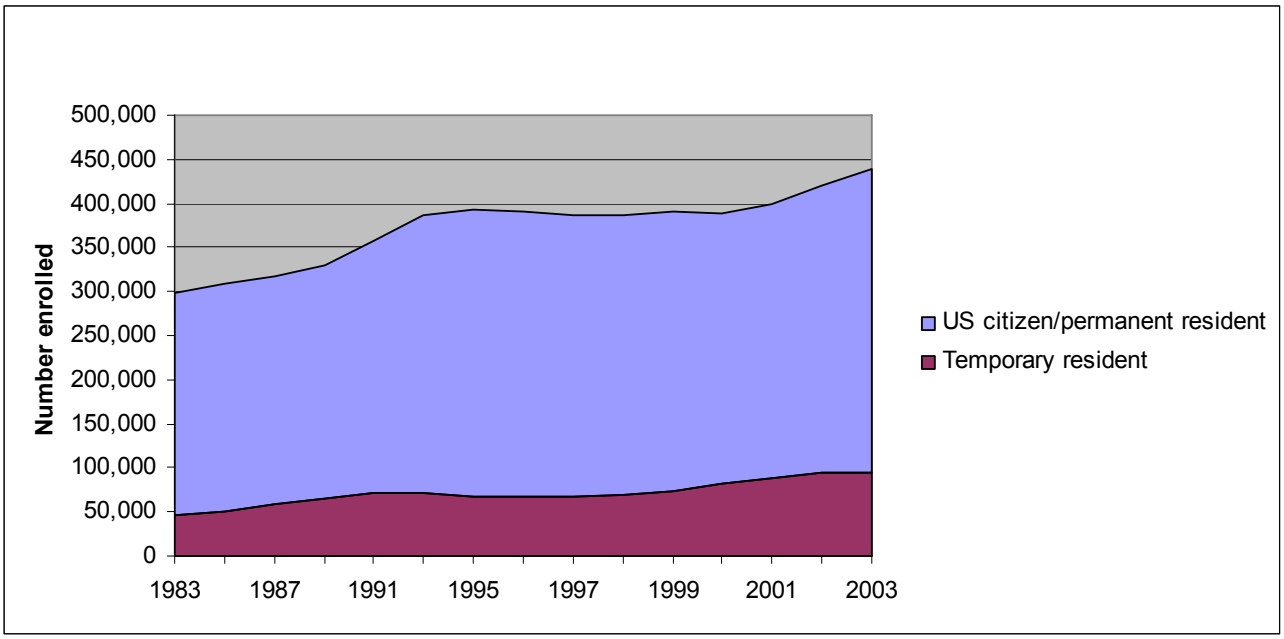
Trends in S&E graduate student enrollments vary by field. American Institute of Physics studies showed that foreign students comprised 54.7 percent and 51.6 percent of physics graduate enrollments in 2000 and 2001, respectively. From 2002 through 2004, the share of foreign student physics graduate enrollments declined from 46.6 percent to 42.6 percent. At the same time, graduate physics degree enrollments increased from 2713 in 2000 to 3040 in 2004.[96] The

[95] National Science Board, *Science and Engineering Indicators 2006, Volume 2*, Arlington, VA: National Science Foundation (NSB 06-01A), Table 2-15. http://www.nsf.gov/statistics/seind06/append/c2/at02-15.xls
[96] Neuschatz, Michael and Patrick J. Mulvey, "Physics Students From Abroad: Monitoring the Continuing Impact of Visa Problems," College Park, MD: American Institute of Physics, #R-440, September 2005.

Council of Graduate Schools found that foreign student applications for graduate engineering programs had the largest decrease for all S&E fields in 2003 (down 36 percent), but also the largest recovery in 2005 (up 17 percent).[97]

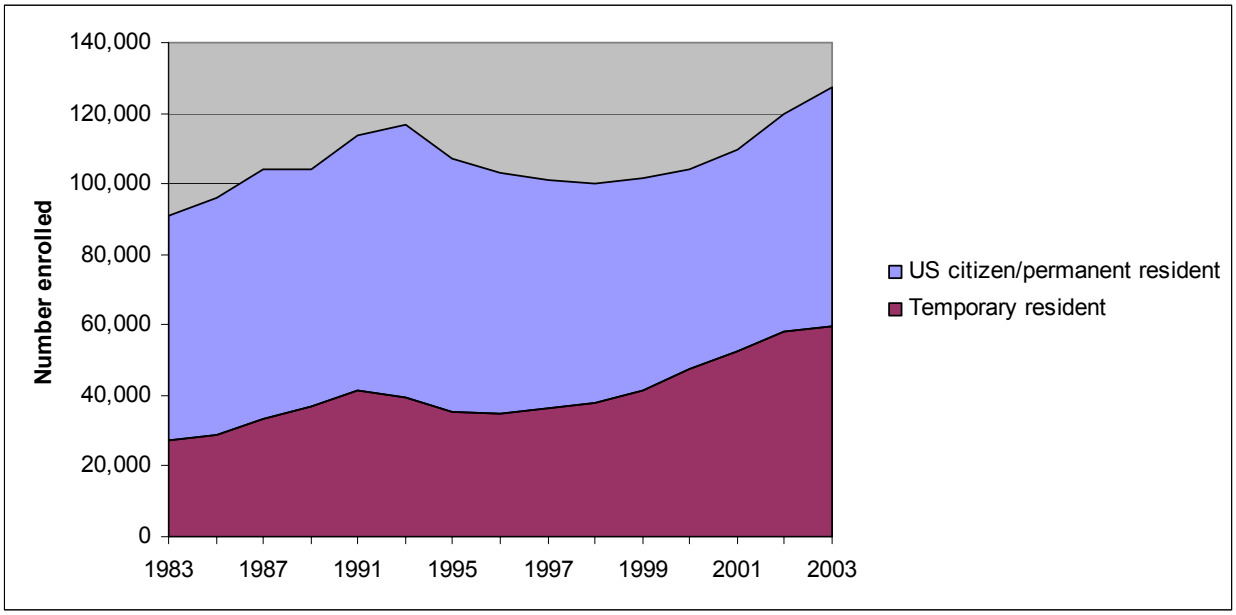
In 2002, 99,173 master's degrees were awarded in S&E fields in the U.S., representing an increase of 53 percent since 1985. An increasing share of those degrees was awarded to temporary residents: 28 percent in 2002, up from 19 percent in 1985.[98] This increase in the foreign student share of masters S&E degrees awarded contrasts sharply with the decline in the foreign student share of bachelor's S&E degrees. Either fewer American graduates with bachelor's S&E degrees are pursuing additional education immediately (*i.e.*, they're entering the job market) or they are switching fields of study.

Chart 4-2
Graduate Enrollment in Science Fields, 1983-2003



[97] Council of Graduate Schools, "Findings from the 2006 CGS International Graduate Admissions Survey, Phase I: Applications," Washington, DC: March 2006.
[98] National Science Board, *Science and Engineering Indicators 2006, Volume 2*, Arlington, VA: National Science Foundation (NSB 06-01A), Table 2-29. http://www.nsf.gov/statistics/seind06/append/c2/at02-29.xls

Chart 4-3
Graduate Enrollment in Engineering Fields, 1983-2003



Borjas found that while the increase in foreign students at the graduate level does not seem to be crowding out Americans in general, it does seem that white male Americans, particularly at elite institutions, are being crowded out.[99] His conclusions are institution-specific, however, and do not speak to the educational system as a whole, nor to the overall impact of foreign students on the educational and career choices of Americans.

Enrollment in Doctoral S&E Degrees Has Increased

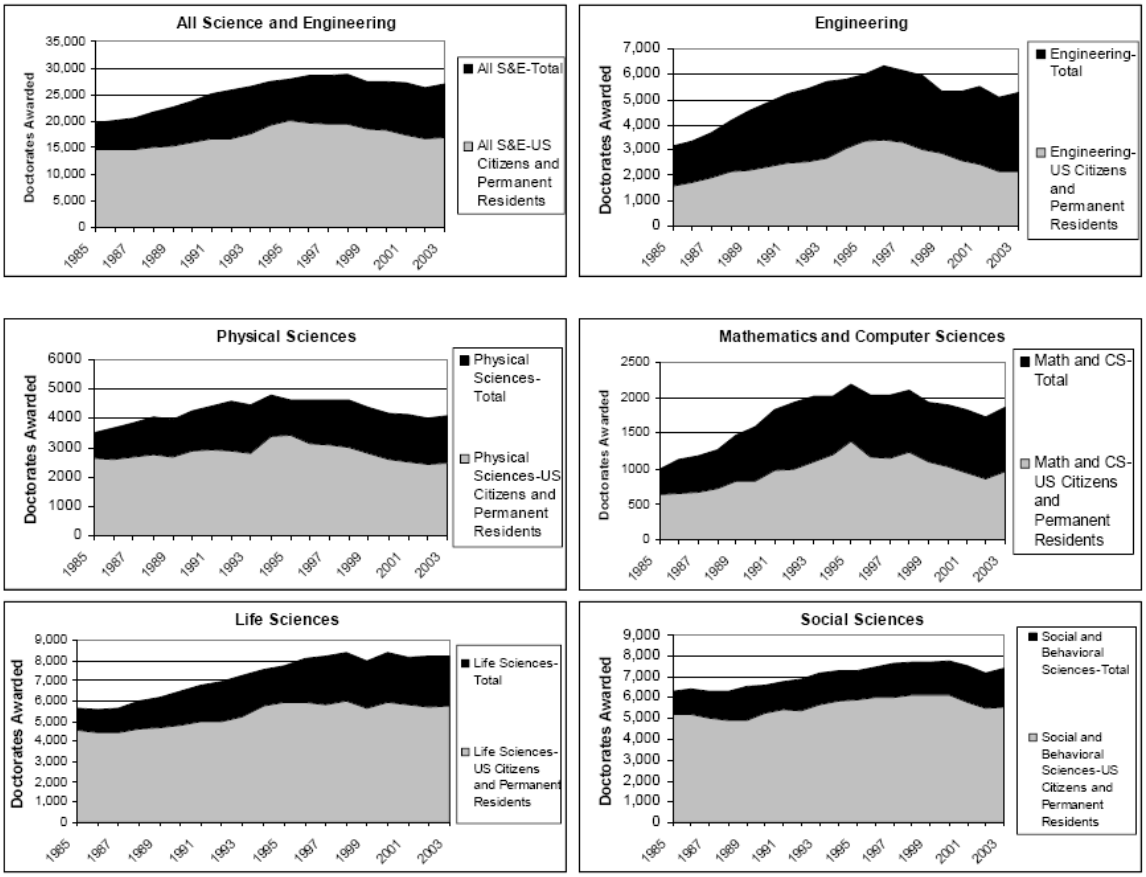
The number of doctorates awarded in S&E fields increased 40 percent over the last twenty years. In 2003, 26,891 S&E doctoral degrees were awarded nationwide, with 5,265 (19.6 percent) in engineering and 21,626 (80.4 percent) in science. In 1983, 19,274 S&E doctorates were awarded, of which 2,781 (14.4 percent) were in engineering and 16,493 (85.6 percent) were in science.[100] In addition to engineering, science specialties increasing their share of S&E doctoral degrees over this period included mathematics/computer sciences (5 percent to 7 percent) and physical/biological sciences (41 percent to 43 percent).

The proportion of foreign students in doctoral programs is also growing. Foreign students earned 8,714, or 32.4 percent, of the 26,891 S&E doctoral degrees awarded in 2003—an 18 percent increase since 1983. They earned 2,909 (55.3 percent) of doctorates in engineering and

[99] George J. Borjas, 2004, "Do Foreign Students Crowd Out Native Students from Graduate Programs?" National Bureau of Economic Research Working Paper No. 10349, Cambridge, MA.
[100] National Science Board, *Science and Engineering Indicators 2006, Volume 2*, Arlington, VA: National Science Foundation (NSB 06-01A), Table 2-42. http://www.nsf.gov/statistics/seind06/append/c2/at02-42.xls

5805 (26.8 percent) in science.[101] NSF captured different numbers but similar trends in its survey of earned graduates, with 38 percent of S&E doctorates awarded to temporary residents—40 percent in the physical sciences and 59 percent in engineering and combined fields of math and computer science.[102] Chart 4-4 shows how the number of temporary residents awarded doctorates has increased as a proportion of the total in all S&E fields.

Chart 4-4
Doctorates Awarded by U.S. Institutions, by Field and Citizenship Status, 1985-2003



SOURCE: National Science Foundation, Survey of Earned Graduates. Arlington, VA: National Science Foundation, 2005.

S&E Postdoctoral Opportunities Have Increased

The number of postdoc students and the proportion that are foreign students have increased significantly in the last 20 years. In 2003, there were 46,715 postdoc students in American universities, a 44 percent increase over 1983. Of these, 26,975 or 57.8 percent went to foreign students. This is a substantial increase since 1983 when foreign students accounted for 36.3 percent of postdocs. Some 8.3 percent of postdocs, or 3,854, were in engineering, and 69.9

[101] Ibid., Table 2-32. http://www.nsf.gov/statistics/seind06/append/c2/at02-32.xls
[102] National Science Foundation, Survey of Earned Graduates. Arlington, VA: National Science Foundation, 2005.

percent of those were held by foreign students.[103] It is unclear how much current visa policies that limit temporary work visas for private, for-profit employers which in turn discourage graduating foreign students from seeking employment to remain in the U.S. are encouraging these students to extend their academic careers.

FOREIGN STUDENT ISSUES

As noted above, foreign students make up a significant portion of students studying S&E in American universities, particularly at the doctoral level. In a globalized world, contact with foreign students benefits American students by exposing them to other cultures and business practices, enabling them to more ably compete in the global market, as well as fostering tolerance. Well-trained foreign students make valuable contributions to the American university system, and upon graduation may contribute significantly to the American knowledge economy by gaining employment here. On the other hand, the U.S. economy may be well-served by having U.S. trained scientists and engineers returning to their home countries to create an enterprise, as opposed to foreign-trained scientists and engineers, because this creates a U.S. connected intellectual and business community. What factors influence whether foreign students come to the U.S. to study, and whether they stay here after completing their studies? We looked at visa issuance, "stay rates," and competitive opportunities.

Student Visa Problems Have Decreased

After September 11, universities across the country complained that there were legions of foreign students who could not enroll in S&E programs because of issues with visas. Sagging foreign student enrollments in university S&E programs would contribute to a decline in university capacity to deliver high-skilled workers to industry if these trends were substantial and continued for an extended period of time.

The American Institute of Physics annually tracks foreign student visa problems for those seeking admission to U.S. university programs. In Fall 2002 and 2004, 30 percent of top physics PhD granting departments, 38 percent of PhD intensive departments and 52 percent of masters granting departments had no visa problems (however, the latter two categories represent smaller departments, which often have few or perhaps no foreign students, so it is not surprising that they would have fewer visa problems). Schools outside the top programs ("other" PhD extensive) tended to have more visa problems. However, in all categories, significantly fewer foreign students were denied entry in Fall 2004 than in Fall 2002.[104] (See Table 4-2.)

[103] National Science Board, *Science and Engineering Indicators 2006, Volume 2*, Arlington, VA: National Science Foundation (NSB 06-01A), Table 2-35. http://www.nsf.gov/statistics/seind06/append/c2/at02-35.xls

[104] Neuschatz, Michael and Patrick J. Mulvey, "Physics Students from Abroad: Monitoring the Continuing Impact of Visa Problems," College Park, MD: American Institute of Physics, #R-440, September 2005, table 3.

Table 4-2
Visa Problems at Graduate Physics Departments, Fall 2004

	Top PhD-Extensive	Other PhD-Extensive	PhD-Intensive	Masters
Percent of Departments with International Students Denied Entry in Fall 2004	27%	52%	54%	25%
Change in Percent from Fall 2002*	-37%	-21%	-7%	-11%
Percent of Departments with No Visa Problems in Fall 2002 & Fall 2004*	30%	15%	38%	52%
Denials as a Percent of Total Non-US Citizens Accepted in Fall 2004	4%	13%	21%	34%
Change in Percent from Fall 2002*	-5%	-10%	-8%	-4%

Source: AIP Statistical Research Center, "Physics Students from Abroad: Monitoring the Continuing Impact of Visa Problems"
* Based on the subset of departments that responded in both 2002 and 2004

The Institute of International Education reported an 8 percent increase over the previous year in new foreign student enrollments in U.S. higher education institutions for 2005/06. This change is attributed to the State Department making changes to its visa policy and reducing visa waiting times last year, as well as enhanced recruitment efforts by American universities. Overall enrollment stabilized in 2005/06 after two years of decline.[105] According to the State Department's Bureau of Consular Affairs, the number of visas issued to foreign students increased 15 percent over last year.[106] For new students at least, it would appear that the effects of September 11 were short-term.

Still, there are barriers to foreign students staying in the U.S. after graduation. For example, there has been no increase in available permanent employment-based immigrant visas since 1990, and the cap on temporary work visas for FY2007 was reached four months before that fiscal year began.[107] Meanwhile, Australia, New Zealand, Canada, France, Sweden, and other countries have been aggressively recruiting foreign students with a combination of American-style programs, free or subsidized tuition, and eased routes for permanent immigration after graduation.[108]

[105] Institute for International Education, "Open Doors 2006," New York: IIE, 2006. http://opendoors.iienetwork.org/page/92270/; http://opendoors.iienetwork.org/?p=89192
[106] Rebecca Knight, "Improved Visa Process Lures Foreign Students Back to the US," *Financial Times* 11/13/06 (get primary source)
[107] Batalova, Jeanne, "Competing for Global Talent: The Race Begins with Foreign Students," *Immigration Policy In Focus* 5(7) September 2006, p. 9.
[108] Ibid., p. 7.

U.S. Remains the Place of Choice for Foreign S&E Students after Graduation

Some claim that because of visa problems, perhaps a certain xenophobia following September 11, and hostility due to perceived losses of jobs to foreigners, foreign students are electing not to remain in the U.S. following graduation in ever increasing numbers. If accurate, this trend could contribute to a shortage of domestic S&E labor and expand the supply of U.S. trained S&E workers overseas, facilitating U.S. business decisions to shift more high-tech services work off-shore.

In the National Science Board's survey of S&E doctoral recipients, 73.6 percent of foreign graduates planned and 51.1 percent had definite plans to stay in the United States following graduation, in the years 2000 to 2003. Percentages of those planning to stay, including those with definite plans, rose steadily from 1992 to 2003. The same trend is seen when broken down by field of study.[109] However, because the data are presented in groups of years, e.g., 2000-2003, specific, detailed changes that may have occurred in response to September 11 cannot be independently observed. Change resulting from perceived hostility about job loss to foreigners could be reflected and is not.

The National Academies found a similar positive trend in stay rates: 71 percent of 2001 foreign doctorate recipients remained in the U.S. post-graduation, compared to 49 percent of 1989 graduates.[110] Again, these data do not reflect any change that may have occurred in response to September 11.

The Oak Ridge Institute calculated the number and percent of S&E doctoral students, by field of study, who were temporary residents and remained in the United States after receiving their degrees. Of those who graduated in 2001, 72 percent were still in the United States in 2002, and 68 percent in 2003. Oak Ridge then calculated stay rates for those receiving degrees in 1998. Similar to the results for 2001 graduates, 66 percent remained in the U.S. in 1999, and 64 percent in 2000.[111] (See Chart 4-5.) The relatively small decline in stay rates among 1998 graduates and 2001 graduates, and the observation that in fact a higher percentage of the 2001 grads decided to remain in the country, suggest that any decline is probably not attributable to recent events, but rather a natural attrition as other opportunities arise.

Very little information exists on how many foreign students become permanent residents. According to Batalova, it is estimated that in the late 1990s, 7 percent of foreign students became permanent residents directly after school, and another 7 percent had temporary work visas and then became permanent residents. In contrast, a 2004 survey suggested that 68 percent of foreign doctoral students intended to remain in the U.S.[112] This implies that demand for permanent residency outstrips the supply of visas, or there are other barriers to obtaining a visa.

---

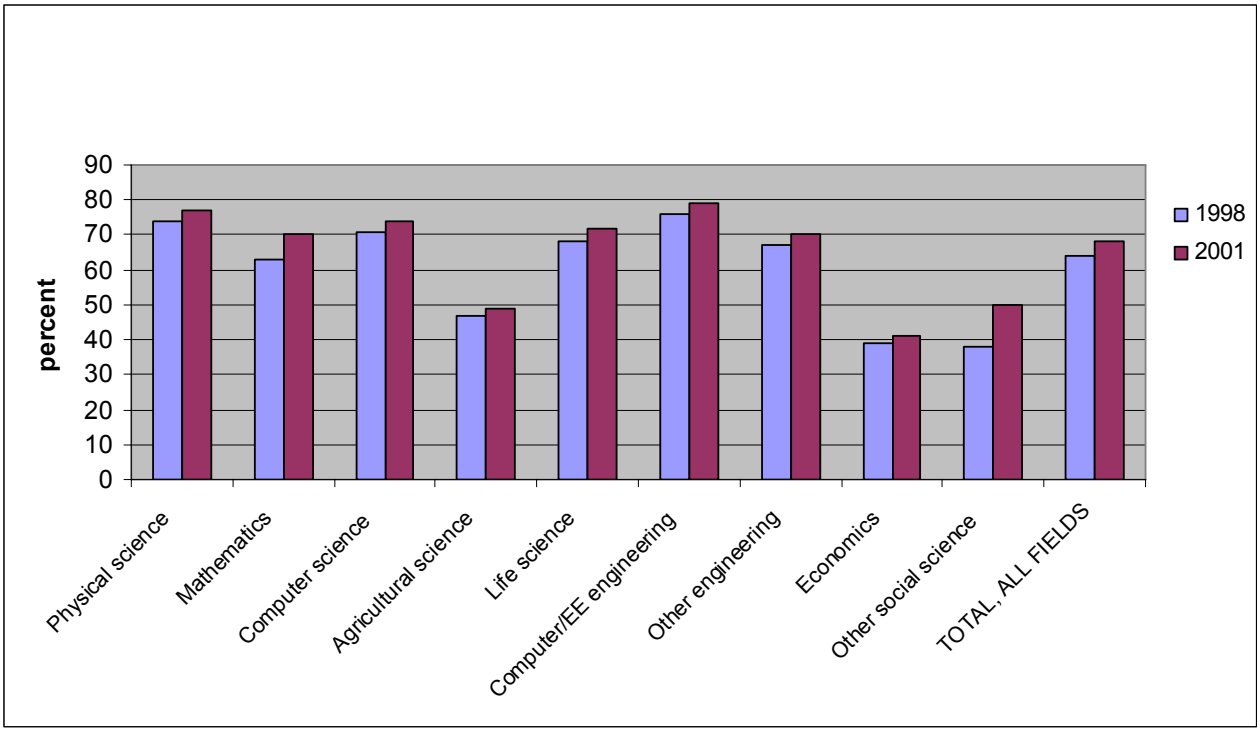
[109] National Science Board, *Science and Engineering Indicators 2006, Volume 2*, Arlington, VA: National Science Foundation (NSB 06-01A), Table 2-33. http://www.nsf.gov/statistics/seind06/append/c2/at02-33.xls

[110] National Academies, *Policy Implications of International Graduate Students and Postdoctoral Scholars in the United States*, Washington, D.C. National Academies Press, 2005.

[111] Finn, Michael G. "Stay Rates of Foreign Doctorate Recipients from U.S. Universities, 2003," Oak Ridge Institute for Science and Education, November 2005, Table 5, and Table 6, p. 6.

[112] Batalova, Jeanne, "Competing for Global Talent: The Race Begins with Foreign Students," *Immigration Policy In Focus* 5(7) September 2006, p. 9.

Chart 4-5
Percentage of Temporary Residents Receiving S&E Doctorates in 1998 and 2001 Who Remain in the U.S. After Two Years



Source: Oak Ridge Associated Universities.

Conditions in Home Countries

Oak Ridge also broke down stay rates by country of origin. Nearly 9 of 10 Chinese and Indian doctoral graduates remained in the United States. By contrast, only about one-third of Japanese and Koreans stayed on,[113] probably reflecting the relatively better economic opportunities (e.g., lower unemployment rates, higher average compensation, and greater advancement opportunities) in their home countries. According to a committee of the National Academies, many developing countries—notably China and India—are persuading their skilled S&E workers to return home by coupling education-abroad programs with investments in the science and engineering infrastructure that will create jobs.[114]

Globally, a shortage of professionals, including engineers and information technology workers, is beginning to threaten growth. A survey of 32,000 companies in 26 countries by recruitment specialists Manpower, Inc. found that overall, 25 percent of companies were paying more than they were a year ago to attract talent and 29 percent would have hired more staff over the last six

[113] Finn, Michael G. "Stay Rates of Foreign Doctorate Recipients from U.S. Universities, 2003," Oak Ridge Institute for Science and Education, November 2005, Table 8.
[114] Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology, "Rising Above The Gathering Storm: Energizing and Employing America for a Brighter Economic Future," Washington, DC: National Academy of Sciences, 2006.

months if they had found suitable candidates. One-third of companies in China, Hong Kong, and India and 45 percent of companies in the U.S. and Japan cited talent shortages. In many countries, the shortage seems especially acute in the services sector.[115]

The dynamic and open U.S. economy continues to offer attractive work opportunities and living conditions for many high-skilled foreign workers and students. However, as the National Academy of Science's Committee on Policy Implications of International Graduate Students and Postdoctoral Scholars in the United States has noted, the challenge for the United States to maintain its leadership and overall excellence in S&E activities is "to attract the best international talent while seeking to improve and invigorate the mentoring, education and training of its own S&E students, including women and underrepresented minority groups. This dual goal is especially important in light of increasing global competition for the best S&E students and scholars."[116]

FOREIGN S&E DEGREE PRODUCTION

According to a report by the American Council on Education, the U.S. is the most popular destination for international students, but other countries are becoming increasingly attractive. While foreign student enrollments grew 17 percent in the U.S. from 1999 to 2004, Britain gained 29 percent, Germany 46 percent and Japan 108 percent.[117] If foreign students are turning away from the U.S. as a first choice in S&E education, then this would add to problems in meeting U.S. demand for high-skilled S&E labor. At the same time, it could increase the supply of high-skilled S&E workers overseas potentially suitable for meeting international demands for S&E labor (i.e., employment in MNCs), thereby increasing opportunities for off-shoring high-tech services. This identifies several critical dimensions that must be considered in evaluating changes in the supply of high-skilled S&E workers overseas. In addition to sheer numbers of S&E foreign workers, it is important to identify qualitative differences, differences in specific skills, and whether the individuals have the language, interpersonal and other skills needed to adapt to the global workplace requirements. Finally, the increasing demand for S&E workers in growing foreign economies, particularly the fast growing emerging giants—India and China—should not be ignored. Much of the increased supply of foreign trained S&E workers will be absorbed by increased foreign demands for those skills. The following sections examine all of these concerns.

[115] Manpower Professional, "Talent Shortage and Wage Inflation Survey: Global Results," October 2006.
[116] Committee on Policy Implications of International Graduate Students and Postdoctoral Scholars in the United States, Board on Higher Education and Workforce, National Research Council, *Policy Implications of International Graduate Students and Postdoctoral Scholars in the United States*, Washington, DC: National Academy of Sciences, 2005. p. 1.
[117] Olga Bain, Dao T. Luu, and Madeleine F. Green, "Students on the Move: The Future of International Students in the United States," *ACE Issue Brief* (October 2006), Washington, DC: American Council on Education.

Foreign Universities Are Producing an Increasingly Larger Share of S&E Students

Undergraduate Degrees

The number of bachelor's or first university degrees awarded in S&E fields internationally has surged over the last couple of decades. In both China and South Korea, the number has more than tripled from the early 1980s to 2002. More modest increases were seen in the United States (31 percent) and Japan (46 percent), while the number doubled in the United Kingdom. Germany saw a 6 percent decrease.[118] Overall, according to National Science Board data, in 2002 China produced the highest proportion of S&E Bachelor's degrees internationally (16 percent). The European Union followed with 15 percent (the United Kingdom alone produced 8 percent [2003]), then the U.S. (12 percent), Central/Eastern European countries (12 percent), Japan (10 percent [2004]), and South Korea (3 percent).[119]

A report by students of the Duke University Master of Engineering Management Program noted that when comparable data are examined (i.e., four-year degrees from accredited schools), the U.S. is still very competitive in its production of S&E bachelor degrees. India produced 112,000 bachelor degrees in engineering, computer science, and information technology in 2004. China produced 351,537 and the U.S. produced 137,537. When normalized against country population, India is producing about 100 bachelor degrees in these fields per one million citizens; China, 270 per million; and the U.S. almost 470 bachelor degrees per million citizens. (The Chinese figure is likely lower, as it includes all degrees with "engineer" in the title—perhaps including mechanics and industrial technicians, and there is no standard definition among provinces for engineers.)[120]

Doctoral Degrees

In 2002, European Union countries accounted for the most earned S&E doctoral degrees (32.6 percent), with the United States second (21.5 percent). Other global competitors included China, 6.5 percent, Japan, 6.1 percent, India, 4.4 percent and South Korea, 2.6 percent. When looking at engineering degrees earned, the European Union maintains the top ranking at 25.7 percent, followed by the United States at 14.7 percent. Other competitors captured an increasingly larger share of engineering degrees: China, 12.1 percent, Japan, 10.9 percent, South Korea, 5.2 percent, India, 2.0 percent, and Taiwan, 1.8 percent.[121]

The increase in doctoral production over the last two decades has been remarkable in Asian countries in particular. Most notably, China produced 65 times more S&E doctorates from 1985 to 2001. Taiwan awarded 20 times more doctorates in 2003 than 1983; South Korea, 11 times

---

[118] National Science Board, *Science and Engineering Indicators 2006, Volume 2*, Arlington, VA: National Science Foundation (NSB 06-01A), Table 2-38. http://www.nsf.gov/statistics/seind06/append/c2/at02-38.xls

[119] National Science Board, *Science and Engineering Indicators 2006, Volume 2*, Arlington, VA: National Science Foundation (NSB 06-01A), Table 2-37. http://www.nsf.gov/statistics/seind06/append/c2/at02-37.xls

[120] Gereffi, Gary et al., "Framing the Engineering Outsourcing Debate: Placing the United States on a Level Playing Field with China and India," Duke University's Master of Engineering Management Program, 2005.

[121] National Science Board, *Science and Engineering Indicators 2006, Volume 2*, Arlington, VA: National Science Foundation (NSB 06-01A), Table 2-40. http://www.nsf.gov/statistics/seind06/append/c2/at02-40.xls

more; Japan, almost 3 times more; and Indian S&E doctorates increased by 63 percent.[122] (Meanwhile, as noted above, U.S. doctorate production in S&E fields increased by 40 percent over the same period.) Such huge increases over relatively short periods not only reflect a relatively small starting base but may also strain the educational system's ability to obtain the resources needed to expand that rapidly while trying to meet or maintain training quality standards.

QUALITATIVE DIFFERENCES AMONG U.S. AND FOREIGN S&E WORKERS

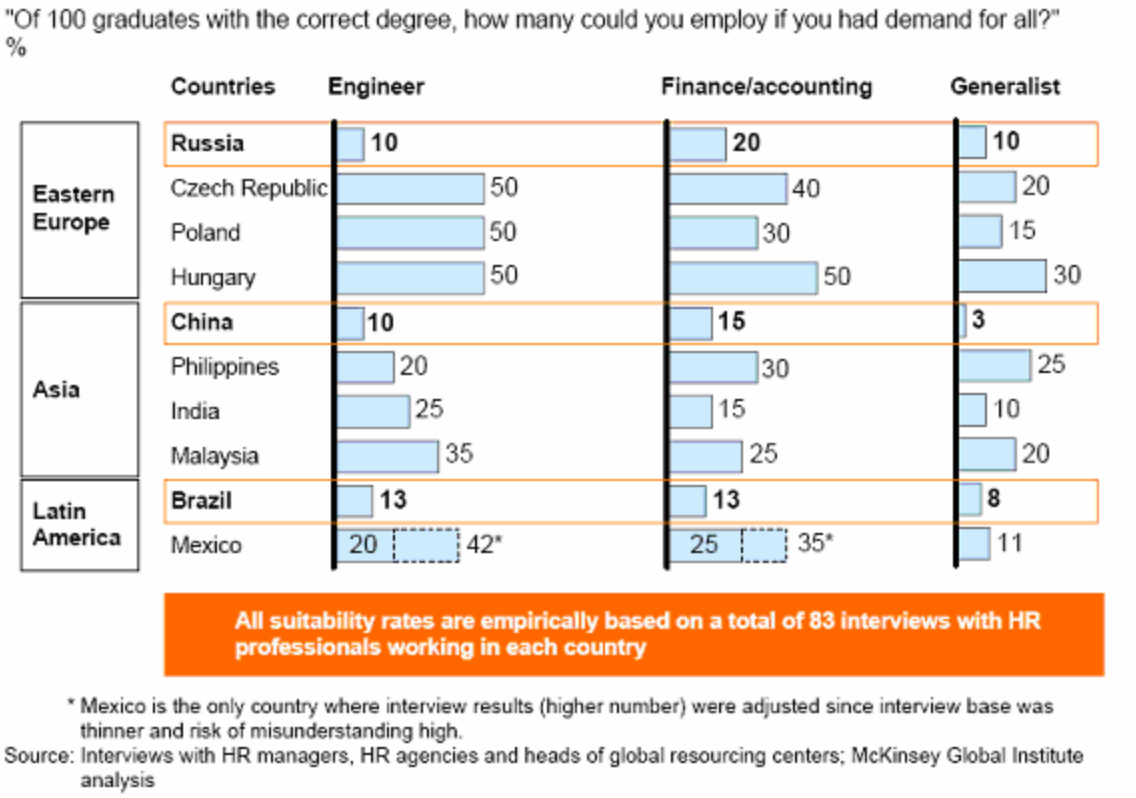
While there is no consensus on how to measure qualitative differences in U.S. and foreign training, there are certainly perceived differences—some subjective and some quantifiable.[123] Degree production numbers cited suggest that many foreign countries have achieved outstanding growth in degree production, but the resource and quality costs are more uncertain. Although difficult to assess, educational quality is believed to depend upon a number of critical inputs and other factors, not the least of which is the quality and preparation of the admitted students. While many American institutions of higher education, particularly the research institutions, continue to be ranked among the highest in the world, there are frequent concerns about the performance of younger American students on math and science achievement tests. More specifically, the continued mediocre performance of American students relative to their foreign peers raises concerns about the ability of future U.S. workers to compete effectively in technically demanding S&E fields.

U.S. Universities Remain Highly Competitive

To compete effectively in an increasingly global S&E labor market may require more skills than simply technical competence in a specific S&E discipline. A survey of 83 human resource managers in multinational companies indicated that only 13 percent of S&E graduates in low-wage countries are suitable for employment by multinational companies. The proportion of suitable candidates varied widely among countries, with as many as 50 percent of engineers from Poland or Hungary being suitable, and only 10 percent and 25 percent of Chinese and Indian engineers being suitable, respectively.[124] (See Chart 4-6.)

[122] Ibid., Table 2-43. http://www.nsf.gov/statistics/seind06/append/c2/at02-43.xls
[123] The OECD is developing an objective assessment of the quality of wealthy countries' university systems, based on its PISA survey, which measures the capabilities of 15-year-olds internationally.
[124] Farrell, Diana, *et al*. *The Emerging Global Labor Market*, McKinsey Global Institute, 2005. p. 31.

Chart 4-6
Suitability of S&E Graduates
(Percent Suitable)



However, according to Farrell et al., the number of suitable young professionals in emerging markets is growing 5.5 percent annually, while the number in developed countries is growing 1 percent. They estimate that by 2008, supply of engineers among the two categories of countries will be about the same.[125]

Low suitability is due to poor quality of education, lack of language skills, cultural differences, and the fact that many graduates do not live in major international cities and are unwilling to move. Quality of education varies substantially among countries. The human resource managers surveyed cited the high-quality of Eastern Europeans' education as being comparable to that in western Europe and the U.S. The Russian and Chinese educational systems were said to be too theory-heavy, while Indian schools below the top tier were inadequate.[126] An Indian study found that despite a large system of higher education and a significant number of S&E graduates, when measured against various competitiveness indices, India ranked poorly on indicators such as publications in peer-reviewed journals, patents, expenditures on R&D, high

[125] Ibid., p. 35.
[126] Farrell, Diana, *et al. The Emerging Global Labor Market: Part II—The Supply of Offshore Talent in Services,* McKinsey Global Institute, 2005, p. 16.

technology exports and royalties and license fees.[127] The study also observed that the quality of higher education in India has deteriorated, particularly in the state universities and at the undergraduate level at affiliated colleges.[128] Lack of English-language proficiency can be a significant problem as well, especially in China and Brazil, human resource managers noted.[129]

Cultural differences include attitudes toward competition and teamwork, ability to work in a hierarchical structure, and flexibility in working hours. Managers generally found a closer cultural fit in workers from countries with historical ties to an MNC's home country.[130]

Finally, lack of accessibility can render a candidate unsuitable. Farrell et al. estimate that 20 percent to 55 percent of Indian, Russian and Chinese graduates are not accessible for hire by multinationals due to dispersion or lack of mobility. Of the three, Chinese graduates are most dispersed, with only 25 percent living near a major international airport, but some would be willing to move, so about half the graduates are accessible. Russian graduates outside the major cities are least willing to move for employment.[131]

Demand for S&E Labor in Foreign Countries Is Increasing

Not all the potentially suitable foreign-trained S&E workers will necessarily be available or wish to work in the global S&E marketplace. Some suitable candidates will choose to work for companies serving their domestic market. For example, Farrell et al. state that in China, domestic companies are increasingly attractive, and as many as half of all suitable, accessible Chinese candidates are choosing to work for companies that do not serve off-shoring demand.[132]

The National Association of Software and Service Companies projects a shortage of 500,000 professional employees in India's technology sector by 2010. Indian companies are scouring universities for engineering talent, and taking measures to improve India's universities by training faculty and improving labs and libraries.[133]

As these emerging economies grow, so will their internal demands for S&E workers, and this is likely to absorb an increasing share of the available supply of foreign trained S&E workers.

Comparative American Student Performance

The ability of U.S. workers to compete in S&E fields in the future depends on a number of elements, but one that has generated much concern is the relatively weak performance of younger American students on math and science aptitude tests. U.S. S&E undergraduate programs report the lowest retention rates of all disciplines, with fewer than half of S&E

[127] Agarwal, Pawan (2006). "Higher Education in India: The Need for Change." Indian Council for Research on International Economic Relations, June 2006, p. 68.
[128] Ibid., 104.
[129] Farrell, Diana, *et al*. *The Emerging Global Labor Market: Part II—The Supply of Offshore Talent in Services,* McKinsey Global Institute, 2005. p. 15
[130] Ibid., p. 17-18.
[131] Ibid., p. 18-19.
[132] Ibid., p. 21.
[133] Somini Sengupta, "Skills Gap Threatens Technology Boom in India," *The New York Times*, 10/17/06.

freshmen completing a degree in those fields throughout the 1990s. How much of this reflects poor preparation received in secondary school is not clear. American 15-year-olds perform below the OECD mean in math and problem-solving.[134] According to the International Association for the Evaluation of Educational Achievement, American eighth-graders are outperformed in math by nine countries and in science by seven countries, but did show improvement in 2003 from 1995. Chinese Taipei, Hong Kong, Japan, Korea, Singapore, Estonia and Hungary bested Americans in both categories.[135] As the head of the indicators and analysis division at the OECD's education directorate commented, it is "realistic to predict that tomorrow's high-skilled jobs in innovation and R&D—and the high wages that go with them—will be relocated in Asia unless the…. U.S. make[s] significant progress."[136] While this may be an overly pessimistic assessment, it is still clear that the U.S. will not be able to maintain its leadership in R&D and other high-tech areas without improving its own student performance and continuing to attract and retain the brightest and best foreign students. America's university system has and can continue to produce a sufficient supply of high-skilled S&E workers, but it requires continued high-quality, well prepared, and motivated students.

U.S. STUDENT CAREER CHOICES

Although there are many factors that make careers in S&E fields less appealing to Americans, four are important: Are foreign students crowding out Americans from S&E university programs they are qualified for? Are degree requirements—especially time to completion—too rigorous or unreasonable? Is tuition too high given return on investment in earning an S&E degree? Are wages in S&E too low to attract Americans?

Foreign Students and Crowding Out

Some argue that foreign students "crowd out" U.S. citizens in the American university system and later, in the job market, and discourage U.S. citizens from pursuing S&E degrees. While trends in undergraduate enrollment and degree data do not support this concern at that level, the same may not be true at higher graduate levels. At these levels, the increasing foreign student share of graduate S&E enrollments and degrees awarded continues to raise "crowding out" concerns. However, according to a committee of the National Research Council, "The evidence that large international graduate-student enrollment may reduce enrollment of domestic students is sparse and contradictory but suggests that direct displacement effects are small compared with pull factors."[137] The committee recommended the U.S. develop a new system of data collection

[134] Based on 2003 data from the OECD's Programme for International Student Assessment (PISA). *Education at a Glance: OECD Indicators 2005*.
[135] International Association for the Evaluation of Educational Achievement, "Trends in International Mathematics and Science Study (TIMSS), 2003." http://nces.ed.gov/pubs2005/timss03/math1.asp; http://nces.ed.gov/pubs2005/timss03/science1.asp
[136] "Nations Anxious to See if They Make the Grade," *Financial Times*, October 18, 2006.
[137] Committee on Policy Implications of International Graduate Students and Postdoctoral Scholars in the United States, Board on Higher Education and Workforce, National Research Council, *Policy Implications of International Graduate Students and Postdoctoral Scholars in the United States*, Washington, DC: National Academy of Sciences, 2005. p.7.

to better understand push-pull factors affecting student choices.[138] Pull factors include time to obtain a degree, funding support for graduate training, and economic opportunities for S&E careers, including remuneration. An additional concern is whether U.S. R&D spending, particularly government R&D spending supporting basic research, will continue to increase sufficiently in the future to provide the fellowship and other support S&E graduate and postdoc fellows have relied on to help finance their advanced S&E training.

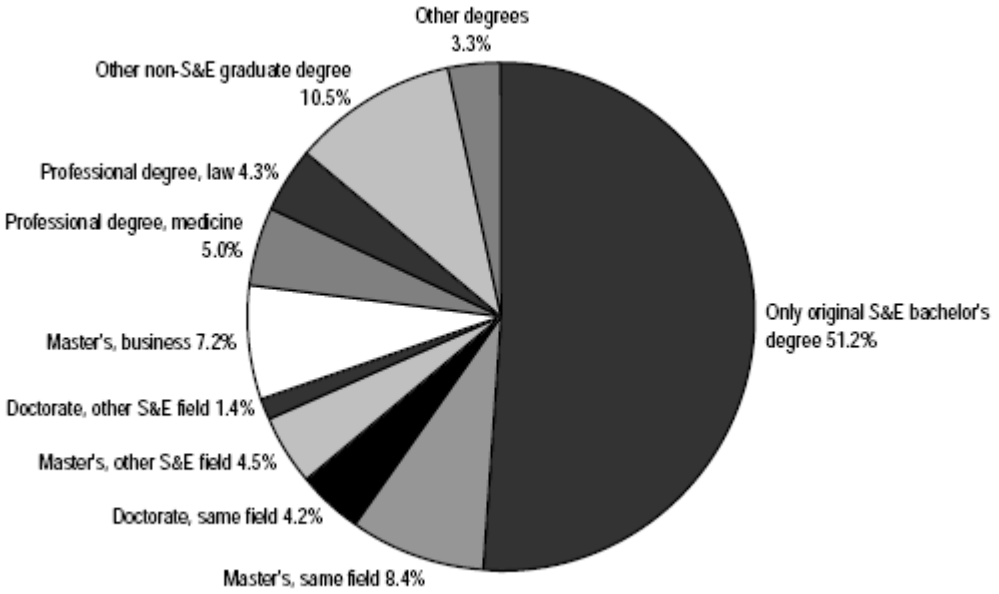
Time to Degree Award Has Increased

According to the President's Council of Advisors on Science and Technology, interest in S&E careers is declining because the time involved in getting an advanced degree is long and increasing. They cite a study finding that the time from bachelor's degree to PhD in biomedical life science had increased from six years in 1971 to 7.8 years in 1996.[139] The National Science Board cites similar increases in training time in S&E fields: e.g., enrollment time from bachelor's to doctorate in engineering increased from 5.9 years in 1983 to 6.9 years in 2003; and from 6.7 years to 7.8 years in computer science.[140] The President's Council added that the requirement for postdoc experience in many S&E fields exacerbates the issue.

This increase in time to obtain an advanced S&E degree reduces the long-term returns to S&E graduate education in two ways. First, it increases the direct education costs for that advanced degree that now involves a longer time period to complete. Second, it delays the start of a fulltime career and may even shorten the total length of that career, thereby reducing the expected lifetime earnings from a career in that field. Given these economic realities, students with an S&E undergraduate degree may decide instead to pursue an MBA, an MD or JD degree, since the training times for these degrees do not appear to have incurred similar increases and salaries for these professional degrees have remained relatively high.[141] According to the National Science Foundation, of the 49 percent of S&E bachelor's recipients who go on to study at the graduate level, over half pursue degrees in non-S&E fields, including business, law and medicine.[142] (See Chart 4-7.)

[138] Ibid., p.131.
[139] President's Council of Advisors on Science and Technology, *Sustaining the Nation's Innovation Ecosystem: Report on Maintaining the Strength of Our Science & Engineering Capabilities,* Washington, DC: June 2004.
[140] National Science Board, *Science and Engineering Indicators 2006, Volume 2*, Arlington, VA: National Science Foundation (NSB 06-01A), Table 2-34. http://www.nsf.gov/statistics/seind06/append/c2/at02-34.xls
[141] President's Council of Advisors on Science and Technology, *Sustaining the Nation's Innovation Ecosystem: Report on Maintaining the Strength of Our Science & Engineering Capabilities,* Washington, DC: June 2004.
[142] Mark C. Regets, "What Do People Do After Earning an S&E Bachelor's Degree?" *InfoBrief* NSF 06-324, Washington, DC: National Science Foundation, July 2006.

Chart 4-7
Highest Degree Earned by Those Who Earned S&E Bachelor's Degrees Before 1994: 2003



Source: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT), 2003.

Funding Support Affects Higher Education Choices

The cost of a public four-year college education has more than doubled over the last twenty years, far outpacing consumer prices.[143] Ability to finance an education can play a large role in deciding whether to pursue that education and what type of education to pursue.

According to Choy and Li, during the 1990s, the cost of college education increased faster than inflation and the 1992 Reauthorization of the Higher Education Act increased eligibility for and availability of Federal loans, together resulting in a dramatic increase in federal borrowing. Between 1992–93 and 2002–03, Federal loan volume at the undergraduate and graduate levels increased 137 percent. However, Choy and Li found that despite the increases in percentage of undergraduate borrowers and average amount borrowed, the median debt burden a year after graduation for 1993 bachelor's recipients and 2000 recipients was about the same. Higher salaries and lower interest rates for the 2000 graduates were cited as the major reasons for this.[144] Choy and Li also found that among undergraduates who borrowed, 26 percent of 2000 graduates

[143] Rep. John A. Boehner and Rep. Howard P. "Buck" McKeon, "The College Cost Crisis: A Congressional Analysis of College Costs and Implications for America's Higher Education System," September 4, 2003, p. 6.
[144] Susan P. Choy and Xiaojie Li, "Debt Burden: A Comparison of 1992-93 and 1999-2000 Bachelor's Degree Recipients a Year After Graduating" (NCES 2005–170), U.S. Department of Education, National Center for Education Statistics, Washington, DC: U.S. Government Printing Office, 2005. p. iii.
[http://nces.ed.gov/pubs2005/2005170.pdf]

took on at least $25,000 of debt, compared to just 7 percent of the 1993 graduates.[145] Nevertheless, the increase in debt did not seem to discourage students from pursuing graduate or first-professional degrees. Indeed, the 2000 cohort was more likely to be enrolled in graduate school than the 1993 cohort one year later (21 percent vs. 16 percent), and S&E majors were even more likely (29 percent vs. 24.5 percent).[146] The study did not indicate whether those individuals pursued a higher degree in S&E or changed fields, but as noted above, according to the National Science Foundation, over half of pre-1994 S&E Bachelor's recipients who pursued advanced degrees switched to non-S&E fields.

Of the 26,891 S&E doctoral students in 2003, most were primarily supported by research assistantships (31.2 percent), fellowships (21.5 percent), teaching assistantships (14.5 percent) or personal resources (15.6 percent). Foreign students were more likely to be funded by research assistantships (46.0 percent) and much less likely to be funded through personal resources (7.1 percent).[147] Among U.S. citizens, 22 percent supported themselves with personal resources. Interestingly, the percentage of U.S. citizens relying on personal resources was higher among females (27 percent) and underrepresented minorities (23 percent).[148] Financial support, then, could be one way to encourage those groups to pursue higher education in S&E.

Compensation for S&E Students Appears Competitive

According to the National Science Board, entry-level salaries for all S&E degree-holders have increased 40 percent on average over the last ten years, from $37,000 in 1993 to $52,000 in 2003. There are substantial variations by field and level of degree. Specifically, an engineer with a bachelor's degree could expect to earn $53,000, a 45 percent increase over 1993. A computer scientist with a master's degree could expect to earn $66,000, a 47 percent increase over 1993. And a scientist with a PhD could expect to earn $50,000, a 32 percent increase. Interestingly, a scientist with a PhD might earn 11 percent less than one with a master's, and a computer/math scientist would earn 2 percent less with a PhD than with a master's.[149] This is likely due to almost half of doctorate holders being employed in academia, while master's degree holders would more likely be employed in private industry. (See Charts 4-8, 4-9, and 4-10; 2001 data not available.)

[145] Ibid., p. 16.
[146] Ibid., p. 21.
[147] However, according to the Institute for International Education's report, "Open Doors 2006," 63% of international students overall (in all fields at all levels) are supported primarily by family and personal sources. http://opendoors.iienetwork.org/?p=89193
[148] National Science Board, *Science and Engineering Indicators 2006, Volume 2*, Arlington, VA: National Science Foundation (NSB 06-01A), Table 2-22. http://www.nsf.gov/statistics/seind06/append/c2/at02-22.xls
[149] National Science Board, *Science and Engineering Indicators 2002, Volume 2*, Arlington, VA: National Science Foundation, Tables 3-30, 3-31, 3-32, 3-33; National Science Board, *Science and Engineering Indicators 2006, Volume 2*, Arlington, VA: National Science Foundation (NSB 06-01A), Table 3-11.
http://www.nsf.gov/statistics/seind06/append/c3/at03-11.xls

Chart 4-8
Median Annual Salaries of U.S. Individuals in Selected S&E Occupations (Entry Level, Bachelor's)

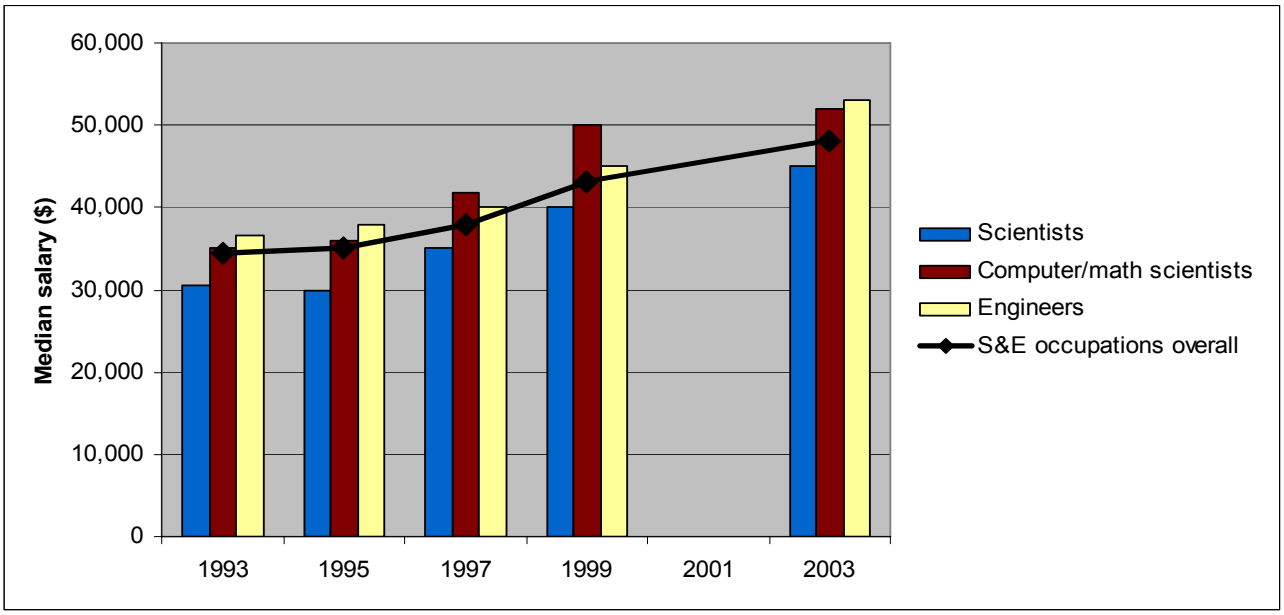


Chart 4-9
Median Annual Salaries of U.S. Individuals in Selected S&E Occupations (Entry Level, Master's)

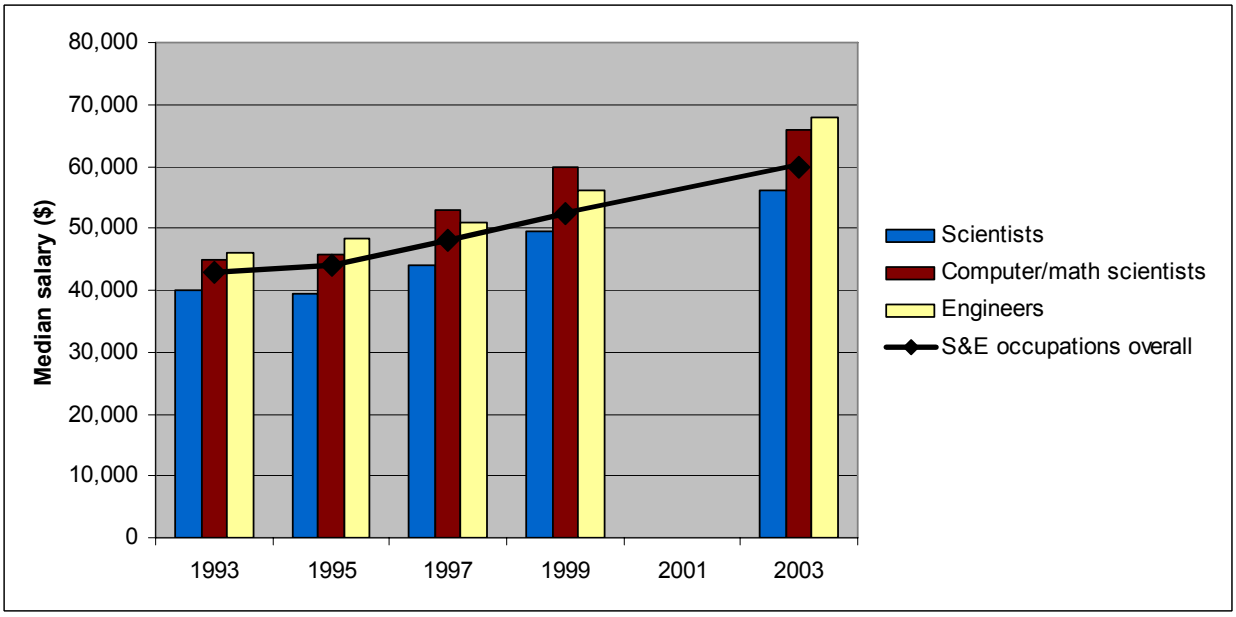
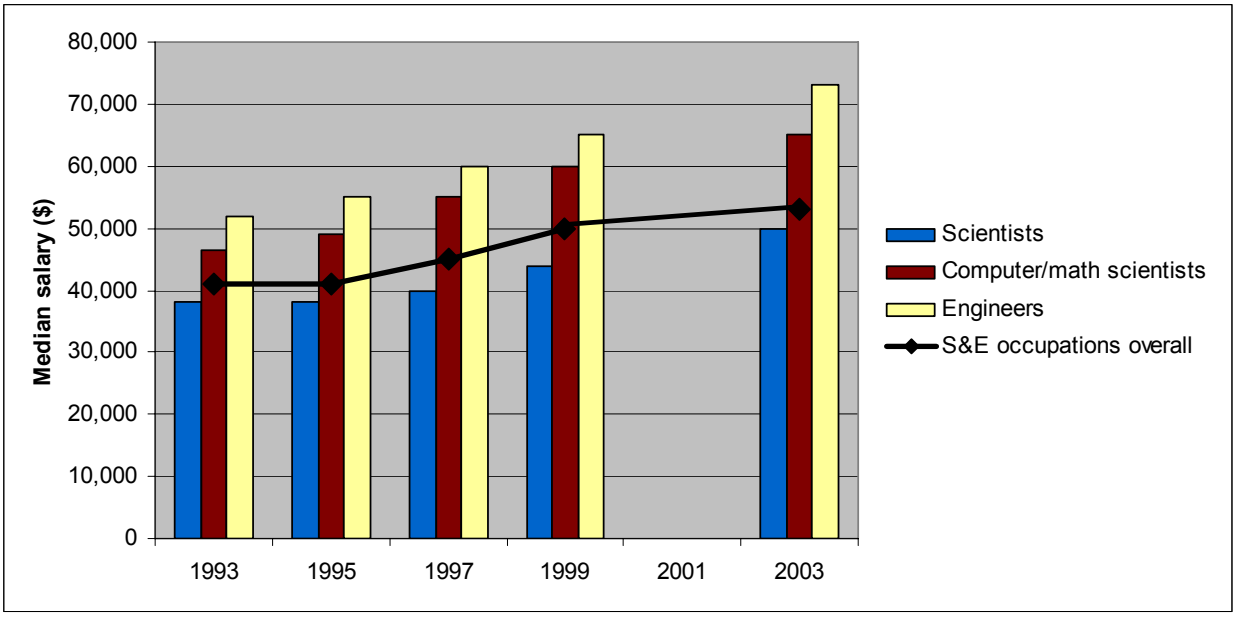


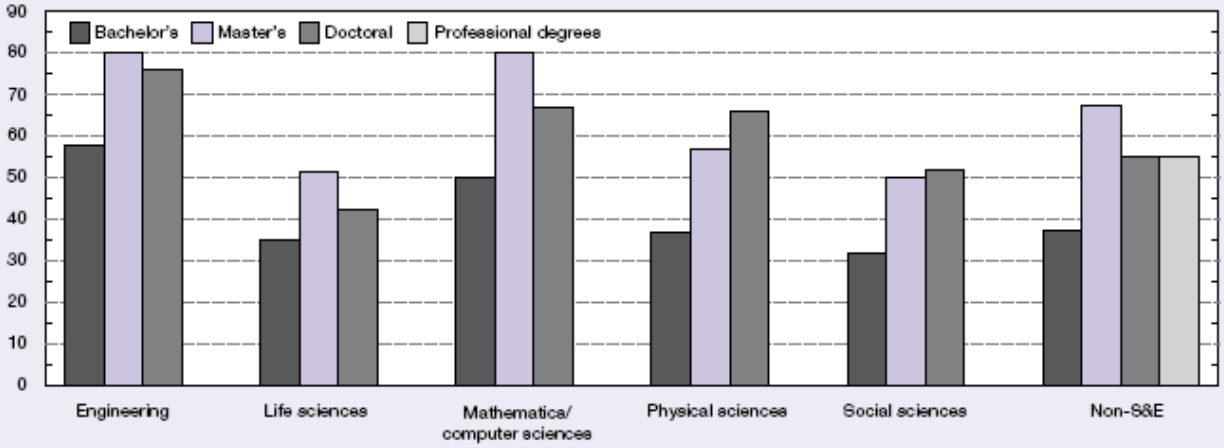
Chart 4-10
Median Annual Salaries of U.S. Individuals in Selected S&E Occupations (Entry Level, PhD.)



National Science Foundation data for salaries one to five years after receipt of degree show that S&E degree recipients' salaries are competitive with non-S&E salaries, including those in law and medicine (included in "professional degrees"). In particular, median salaries for the engineering and math/computer science fields were significantly higher in 2003 than non-S&E fields and most other S&E fields, for all degree levels. (See Chart 4-11.)[150] These median "entry level" salary data suggest that S&E fields, especially engineering and mathematics/computer science, appear sufficient to attract an adequate supply of newly trained S&E workers.

[150] National Science Board, *Science and Engineering Indicators 2006, Volume 1*, Arlington, VA: National Science Foundation (NSB 06-01), Figure 3-8.

Chart 4-11
Median Salaries of Degree Recipients 1–5 years After Degree, by Field and Level of Highest Degree: 2003



NOTE: Non-S&E fields include the SESTAT categories of "non-S&E" and "S&E-related."

SOURCE: National Science Foundation. Division of Science Resources Statistics, National Survey of College Graduates, preliminary estimates (2003)

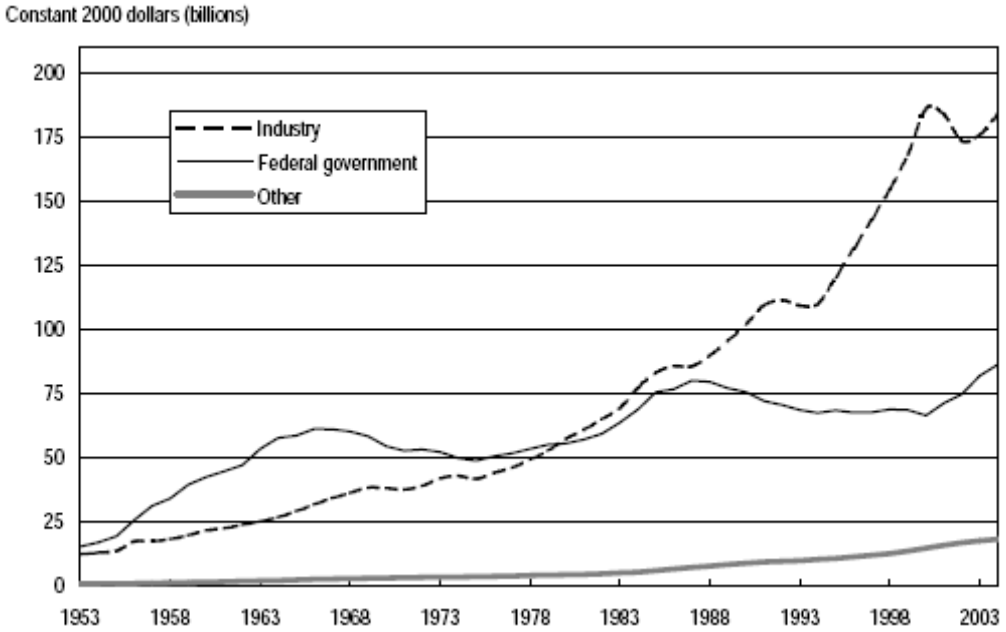
Science and Engineering Indicators 2006

Federal R&D Funding for Basic Research Has Been Stagnant

Historically, government investment in R&D has supported basic research rather than development, which is the principal focus of much private sector R&D investment. As such, government R&D spending has been the financing source for many graduate and postdoc fellowships, research grants and related jobs. As shown in Chart 4-12, the Federal share of total U.S. R&D has been declining for decades, dropping below 50 percent in 1979 and reaching a low of 25 percent in 2000. However, the Federal share was projected to increase to 30 percent in 2004,[151] as Federal funding of R&D increased 23 percent from 2000 to 2004 in constant dollars.[152] Federal funding of basic research at universities and colleges increased 27 percent from 2000 to 2004 after adjusting for inflation.[153] Nevertheless, in most S&E fields a higher percentage of academic researchers had Federal support for their work in the 1980s than in 2003. Moreover, according to the National Science Board, "Early receipt of federal support is viewed as critical to launching a promising academic research career," but recent doctoral recipients were less likely than the overall S&E doctoral workforce to receive support.[154]

[151] National Science Board, *Science and Engineering Indicators 2006, Volume 1*, Arlington, VA: National Science Foundation (NSB 06-01), chapter 4.
[152] National Science Foundation, Division of Science Resources Statistics, National Patterns of R&D Resources (annual series). [http://www.nsf.gov/statistics/infbrief/nsf06306/figure1.xls]
[153] http://www.nsf.gov/statistics/nsf06327/tables/tab3.xls
[154] National Science Board, *Science and Engineering Indicators 2006, Volume 1*, Arlington, VA: National Science Foundation (NSB 06-01), chapter 5.

Chart 4-12
U.S. R&D, by funding sector: 1953–2004

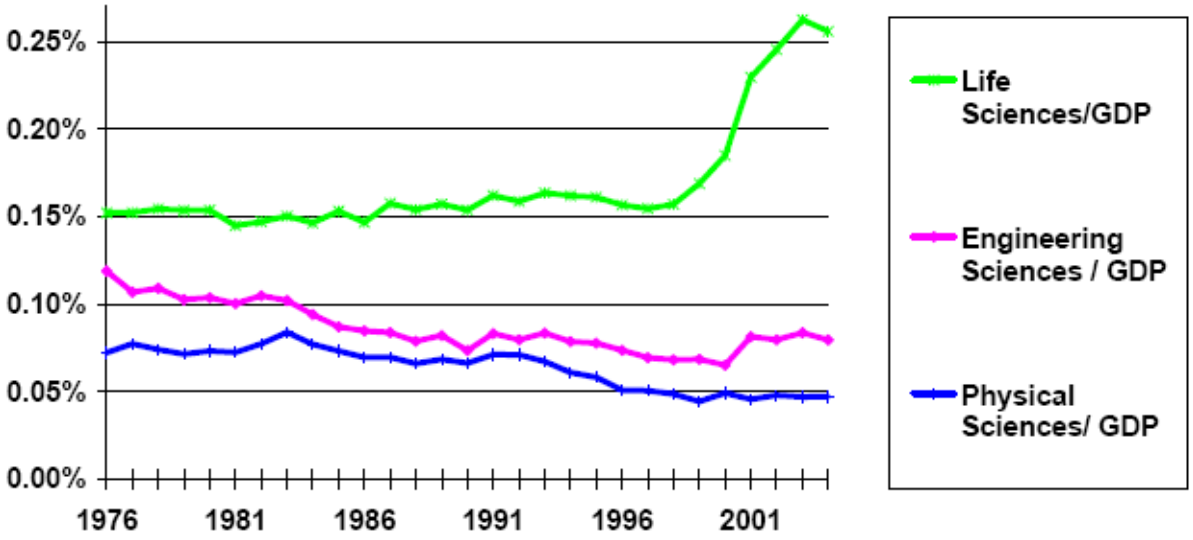


SOURCE: National Science Foundation, Division of Science Resources Statistics, National Patterns of R&D Resources (annual series). In Brandon Shackelford, "U.S. R&D Continues to Rebound in 2004," *SRS InfoBrief* (NSF 06-306), National Science Foundation, January 2006.

As shown in Chart 4-13, federal R&D expenditures in S&E fields relative to GDP have been relatively stagnant since the 1970s, with the exception of the life sciences, as manifested in a doubling of NIH's budget over five years beginning in 1998.[155] As noted by a committee of the National Academies, "A balanced research portfolio in all fields of science and engineering research is critical to U.S. prosperity. Increasingly, the most significant new scientific and engineering advances are formed to cut across several disciplines."[156] A targeted increase in R&D funding in certain S&E fields, such as engineering, physical sciences, and mathematics, would provide that balance and support additional academic researchers, particularly those early in their careers. This could encourage more individuals to pursue careers in S&E fields. Conversely, lack of R&D support may drive foreign students to other countries or American students to other disciplines where support may be available.

[155] American Association for the Advancement of Science, "Trends in Federal Research by Discipline, FY 1976-2004." http://www.aaas.org/spp/rd/discip04c.pdf.
[156] Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology, "Rising Above The Gathering Storm: Energizing and Employing America for a Brighter Economic Future," Washington, DC: National Academy of Sciences, 2006. p. ES-6.

Chart 4-13
Trends in Federal Research by Discipline, FY 1976-2004
Obligations for Research Gross Domestic Product



Source: National Science Foundation, *Federal Funds for Research and Development FY 2002, 2003, and 2004*, 2004. FY 2003 and 2004 data are preliminary. GDP figures from Budget of the U.S. Government FY 2005. © 2004 AAAS

CONCLUSIONS

Based on our assessment of the literature, the Panel arrived at the following conclusions:

- U.S. universities continue to meet much of U.S. business demands for high-skilled S&E workers. As such, they appear to be helping to reduce any need or incentive to off-shore high-tech services.

- Critical in meeting the demand for S&E labor is the reliance on foreign students attending American universities. Foreign students do not appear to be displacing large numbers of Americans who would like S&E jobs. And foreign students not remaining in the U.S. after graduation may create economic opportunities for U.S. industry.

- Although visa problems for foreign students after September 11 appear to have abated, the U.S. cannot afford barriers that impede U.S. universities' ability to attract and train the best S&E students from either foreign or domestic sources in a more globalized S&E market. Student enrollments in S&E programs and subsequent career choices should reflect informed economic choices, not decisions constrained by legal, cultural or other considerations.

- Other economies and their higher education systems—especially India and China—are competing with American universities to supply S&E workforce needs in a more globally integrated market. Maintaining and enhancing qualitative differences for U.S. university

S&E graduates relative to these emerging foreign graduates will be critical for sustaining any U.S. competitive advantage, since population size differences will ultimately determine relative quantitative production levels.

RECOMMENDATIONS

To improve the ability of the U.S. university system to respond to the challenges it faces from a more intensely competitive and increasingly globalized S&E labor market, the Panel recommends:

- **The President and Congress rexamine policies that limit or impose barriers on foreign students who seek S&E education in the United States, and who wish to remain in the country once their education is completed.** Changes might include removing the statement on student visas that the student does not intend to remain in the U.S. Such changes would make it easier for foreign students to attend international conferences or visit home. And they could alleviate concerns about U.S.-trained foreign workers returning home and attracting off-shoring of services.

- **Universities strengthen their capacity to produce S&E graduates in a more competitive global labor market.** This will include sustaining the strong institutional links with industry users of R&D, maintaining investment levels for basic, applied and developmental R&D, and preserving access for qualified American and foreign students.

- **The Department of Homeland Security modify existing administrative data systems and data elements collected to track the subsequent work and residency choices of graduating foreign students.** This would provide a better understanding of their role in meeting U.S. needs for high-skilled S&E workers in a more intensely competitive global labor market. As an example, applications for permanent residency should include previous status (e.g., student, H1-B holder, etc). Creating a consistent identifier for foreign students and workers in the U.S. would allow existing data systems to be linked to help determine future foreign student career and residency choices.

CHAPTER FIVE

WHAT ARE THE EFFECTS OF FOREIGN DIRECT INVESTMENT ON U.S. EMPLOYMENT?

With the rise of globalization, more and more firms are shifting business activities and related jobs to locations outside of their home countries. The average net direct investment capital outflows for U.S. direct investment abroad (off-shoring) for years 2000 to 2005 was $123.6 billion. In contrast, the average net direct investment capital inflows for foreign direct investment in the U.S. (in-shoring) for the same period was $137.1 billion.[157] While some U.S. foreign direct investment outflows support off-shoring activities by U.S. businesses, and can shift some American jobs to foreign labor markets, the U.S. labor market benefits from jobs gained through in-shoring the United States.

There have also been increasing concerns about the impact of services off-shoring on the ability of the U.S. to maintain its leadership role in research, development and testing (RDT) activities supporting future economic growth and the creation of innovative technologies to sustain that growth. Foreign direct investment of U.S. MNCs and foreign MNCs has supported an expansion in affiliated trade between MNC parents and their foreign affiliates, including trade in RDT services.

The Panel addressed two questions:

- How much foreign direct investment occurred in the United States from 1980 to 2004 and what were its effects on U.S. employment and GDP?

- How has affiliated trade in RDT services within U.S. MNCs, and foreign MNCs with U.S. affiliates affected the evolving U.S. RDT services leadership role in a more integrated global economy and a globalized S&E market?

The Panel finds that:

- U.S. affiliates of foreign MNCs have accounted for a growing number of U.S. jobs and increasing value added in both the manufacturing and services sectors over the last 24 years.

- Recent trends in U.S. affiliated trade in RDT services within foreign MNCs indicate a faster growth in net exports than similar affiliated trade between U.S. MNCs and their foreign affiliates, suggesting that these foreign MNCs view the U.S as a leader in RDT services.

[157] Bureau of Economic Analysis, U.S. Direct Investment Abroad: Country and Industry Detail for Capital Outflows, http://www.bea.gov/bea/di/usdiacap.htm#2000; and Foreign Direct Investment in the U.S.: Country and Industry Detail for Capital Inflows, http://www.bea.gov/bea/di/fdi21web.htm#2001.

The Panel recommends that the contributions of in-shoring activity to the U.S. economy and, more specifically, United States employment levels, be included in any comprehensive assessment of the economic effects of off-shoring.

As noted in the Academy Panel's first report, "trade and investment flow in both directions between trading partners,"[158] and these flows can be affected by policy interventions intended to address problems, real or perceived, due to off-shoring. Thus, the impacts of in-shoring must be assessed not only to establish their economic effects on the U.S., but also because these in-shoring activities are vulnerable to protectionist policy interventions that attempt to impede trade or foreign investment activity that limits the extent of future off-shoring by U.S. firms.

DEFINING IN-SHORING AND ITS PRINCIPAL ECONOMIC EFFECTS

In the Academy Panel's first report, *Off-shoring: An Elusive Phenomenon*, the Panel defined "in-shoring" as: "foreign firms shifting services and manufacturing activities to the United States to either unaffiliated firms or their own affiliates."[159] Although the U.S. labor market benefits from foreign firms importing from unaffiliated U.S. firms, we examine only annual changes in the operations and activities of U.S. affiliates of foreign MNCs, and the related effects on U.S. employment and affiliated trade in RDT services. Also, we focus not on the actual shifting of services and manufacturing activities to U.S. affiliates of foreign MNCs, but rather on the effects these shifts have on value added created in the U.S. and the amount of employment accounted for by these U.S. affiliates.

In the Academy Panel's second report, *Off-shoring: How Big Is It?*, the Panel distinguished between "business restructuring off-shoring" and "global expansion off-shoring" as follows:

"Off-shoring due to business restructuring results from a business' decision to restructure all or part of its internal production processes and to obtain those restructured intermediate inputs from a foreign supplier;" and

"Off-shoring due to global expansion arises from a business' decision to expand its operations or production activities globally."[160]

For U.S. MNCs, the distinction between these two different types of off-shoring was particularly important because each had very different economic effects, especially initial direct employment effects. These two distinctions are also applicable to the in-shoring activities from foreign direct investment in the United States. However, there are not the same differential effects on U.S. employment for in-shoring due to business restructuring and in-shoring due to global expansion by foreign MNCs as there are for these two types of off-shoring by U.S. MNCs.

[158] National Academy of Public Administration, *Off-shoring: An Elusive Phenomenon*, January 2006, p. 84.
[159] Ibid, p. 38.
[160] National Academy of Public Administration, *Off-shoring: How Big Is It?*, October 2006, p. 13.

In the case of in-shoring due to business restructuring, foreign MNCs substitute imported services for their own country labor in their internal production processes. The increase in U.S. exports as foreign MNCs import additional services or products from their U.S. affiliates positively affects U.S. employment. In-shoring due to global expansion occurs when a foreign firm decides to shift services and/or manufacturing activities to the U.S. by opening up a new U.S. affiliate, or decides to expand the operations of an existing one to serve growing U.S. or other regional market demands (e.g., Canada or Mexico). In-shoring due to global expansion typically leads to direct increases in U.S. employment, and an increase in value added created in the U.S. by these global expansion in-shoring activities also benefits the U.S. labor market by supporting increased indirect employment.

EMPLOYMENT, AVERAGE EMPLOYEE COMPENSATION AND VALUE ADDED OF U.S. AFFILIATES OF FOREIGN MNCS

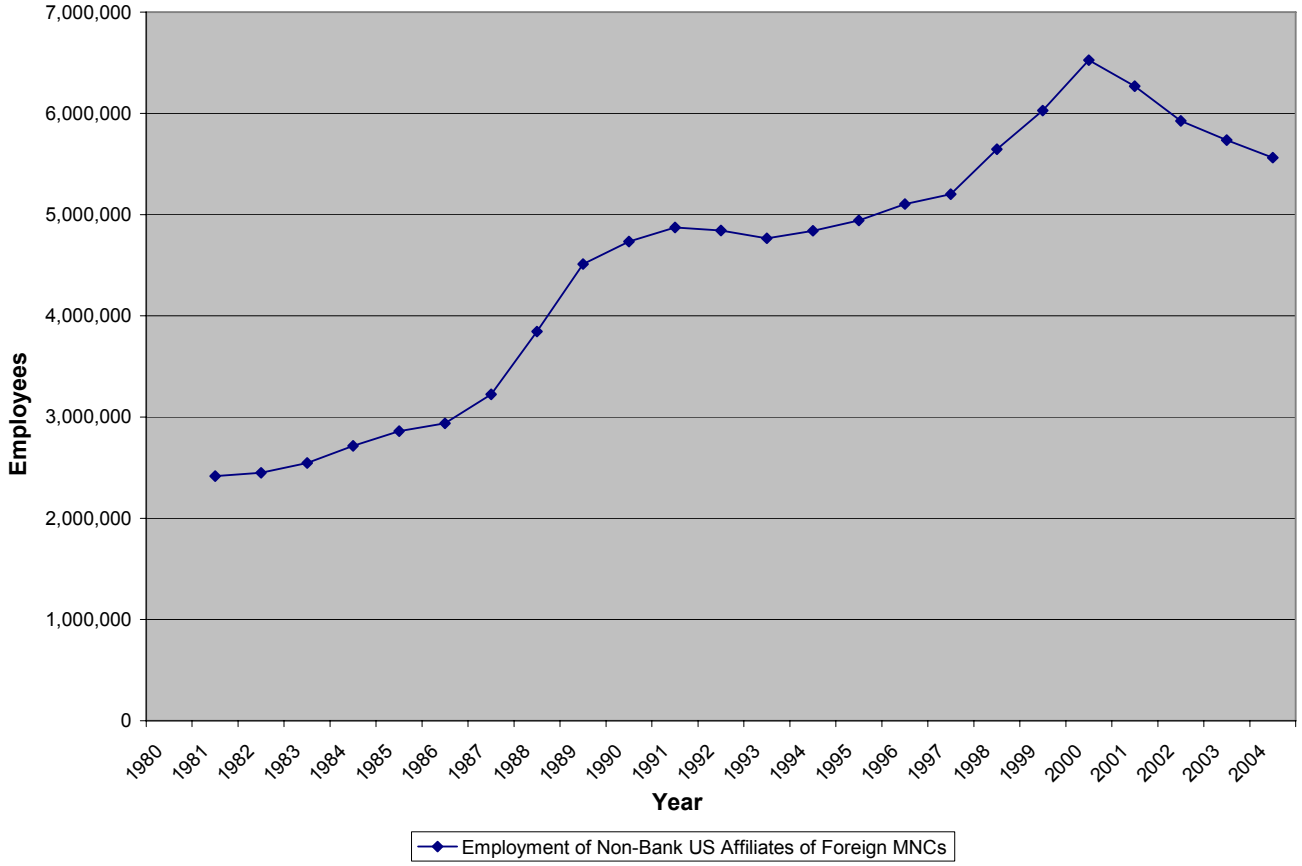
According to Bureau of Economic Analysis (BEA) data,[161] U.S. affiliates of foreign MNCs have a significant presence in the U.S. labor market. The employment of U.S. affiliates of foreign MNCs grew substantially from 1980 to 2004, indicating positive effects of in-shoring due to business restructuring and global expansion. Some of the increases in U.S. affiliate employment however reflect transfers in ownership of existing U.S. companies to foreign MNCs. Both manufacturing and services employment of U.S. affiliates increased during the period, but U.S. affiliate services employment increased at a considerably faster rate. Average employee compensation and value added of U.S. affiliates also increased during the 24-year period.

U.S. Affiliate Employment Is Increasing

Employment of non-bank U.S. affiliates of foreign MNCs steadily increased during the period, more than tripling from 2 million in 1980 to 6.5 million in 2000 (See Chart 5-1). By 2001 however, non-bank U.S. affiliate employment began to fall, down to 5.6 million in 2004, a 14 percent decrease from 2000 to 2004. Increases in employment of U.S. affiliates of foreign MNCs from 1980 to 2004 could be due to foreign establishment of new business enterprises, expansion of already existing U.S. affiliate operations, or foreign acquisitions of U.S. companies.

[161] Data for this analysis come primarily from Bureau of Economic Analysis (BEA) financial and operating data of U.S. affiliates of foreign MNCs. BEA designs and conducts mandatory surveys to collect these data annually.

Chart 5-1
Employment of Non-Bank U.S. Affiliates of Foreign MNCs
(1980 to 2004)

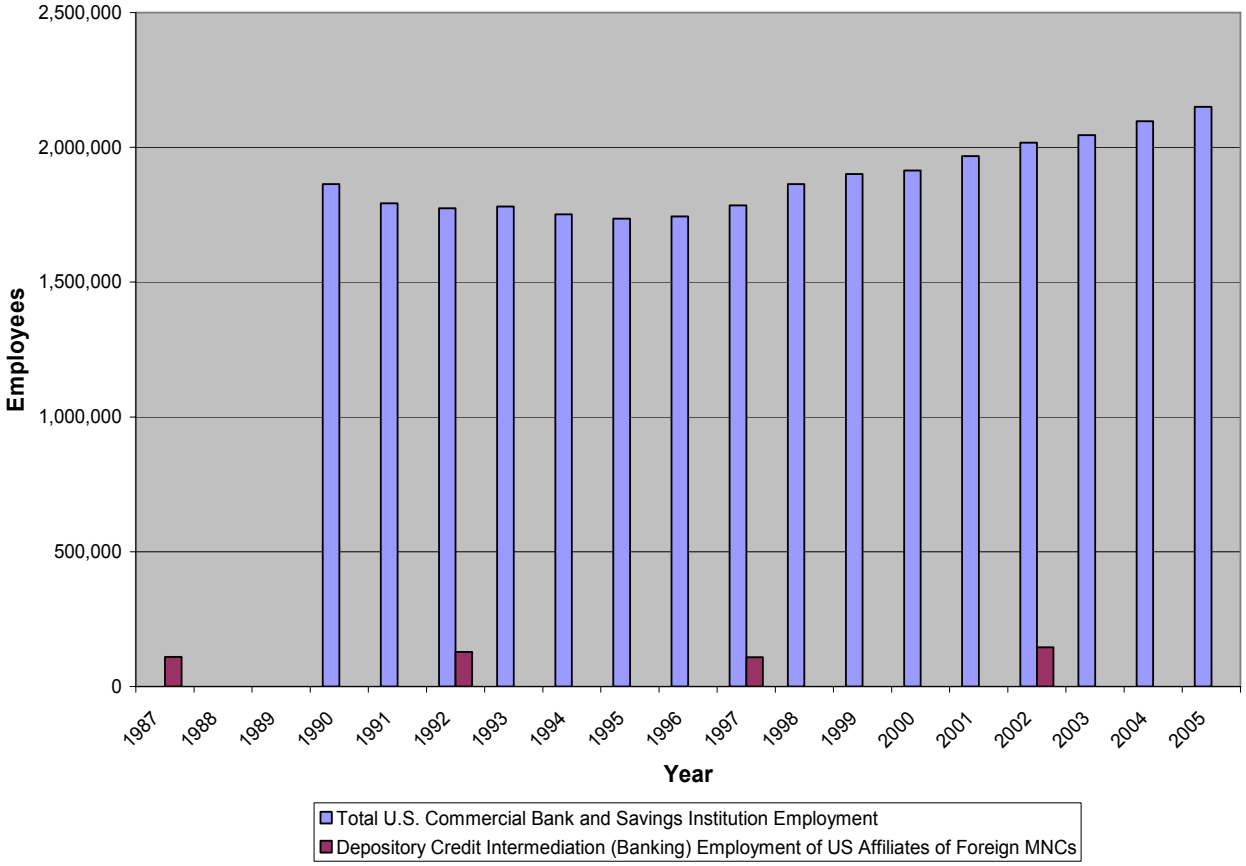


Source: Bureau of Economic Analysis, B. Operations of U.S. Affiliates of Foreign Companies, Comprehensive Financial and Operating Data.

Banking employment of U.S. affiliates oscillated slightly during the four benchmark years, with employment at 110,000 in 1987 and 145,000 in 2002 (See Chart 5-2).[162] Total U.S. banking employment increased from 1.9 million in 1990 to 2.2 million in 2005. Accordingly, U.S. banking affiliates have accounted for a 7.2 percent share of total banking employment in 1992, a 6.1 percent share in 1997, and a 7.2 percent share in 2002.

[162] These time series were used because BEA collects employment data for U.S. affiliates engaged in depository credit intermediation (banking) for benchmark years only, and the thrifts regulated by the Office of Thrift Supervision (OTS) did not report their employment to the FDIC until 1990.

Chart 5-2
Banking Employment of U.S. Affiliates of Foreign MNCs (1987, 1992, 1997 and 2002) and U.S. Commercial Bank and Savings Institution Employment (1990 to 2005)



Source: Bureau of Economic Analysis, B. Operations of U.S. Affiliates of Foreign Companies, Comprehensive Financial and Operating Data.

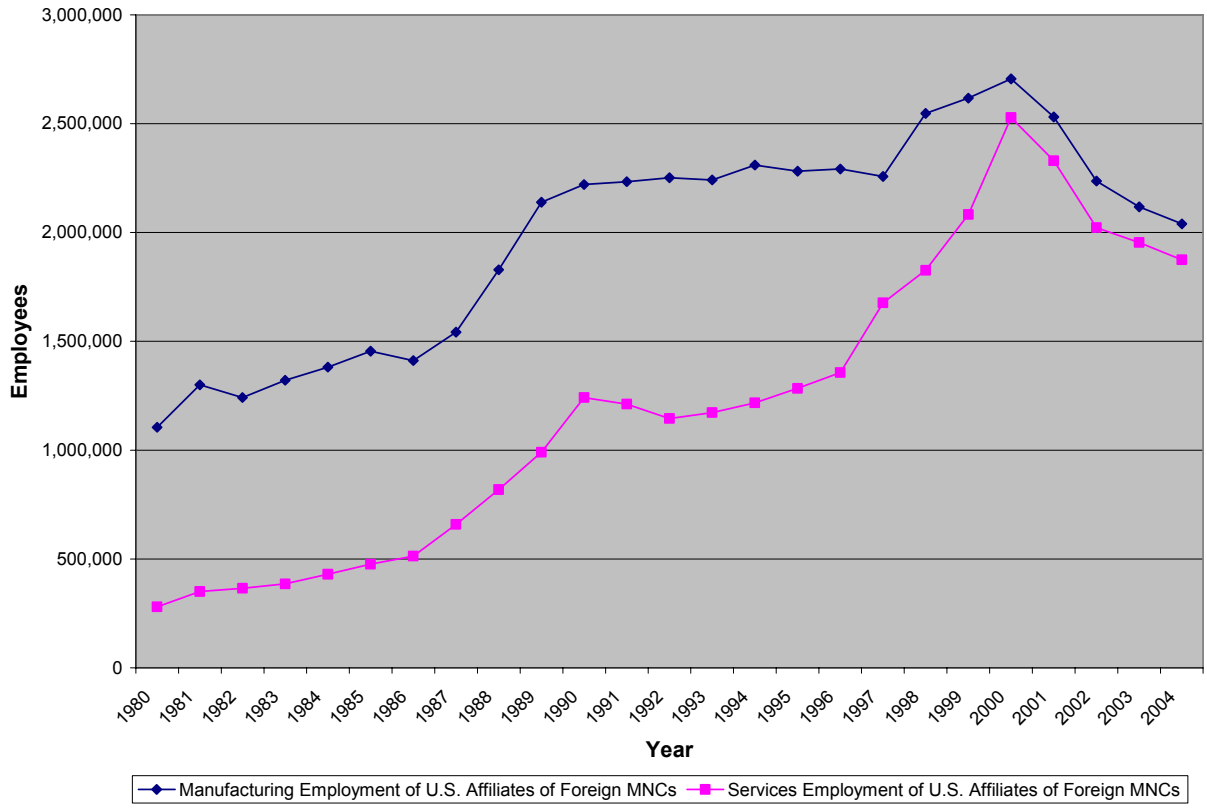
Employment in Manufacturing and Services of U.S. Affiliates Is Increasing

As shown in Chart 5-3, manufacturing and services employment of U.S. affiliates increased from 1980 to 2004 with the steepest increase occurring in services employment beginning in 1996. Manufacturing employment increased from 1.1 million employees in 1980 to 2 million employees in 2004, and services employment increased from 824,000 employees in 1980 to 1.9 million employees in 2004. U.S. affiliate manufacturing and services employment spiked in 1999 at 2.6 million and 2 million, respectively. U.S. affiliates provided more manufacturing jobs in the U.S. during the period than services jobs. Starting in 1996 however, the difference between the amount of U.S. affiliate manufacturing and services employment diminished substantially.

The continued growth in the number of manufacturing jobs in U.S. affiliates from 1980 to the peak in 2000 contrasts sharply with the overall decline in total U.S. manufacturing employment over this period. Overall manufacturing employment in the U.S. fell from 18.7 million

employees in 1980 to 14.3 million employees[163] in 2004. BEA estimates that manufacturing employment in U.S. affiliates accounted for 11.8 percent of total U.S. non-bank private manufacturing employment[164] in 2004, but the percentages were substantially higher in selected industries for the same year. For example, U.S. affiliates accounted for 28.2 percent of total U.S. chemical industry employment and 24 percent of total motor vehicle employment.[165]

Chart 5-3
Manufacturing and Services Employment of Non-Bank U.S. Affiliates of Foreign MNCs
(1980 to 2004)



Source: Bureau of Economic Analysis, B. Operations of U.S. Affiliates of Foreign Companies, Comprehensive Financial and Operating Data.

Average Employee Compensation of U.S. Affiliates Is Increasing

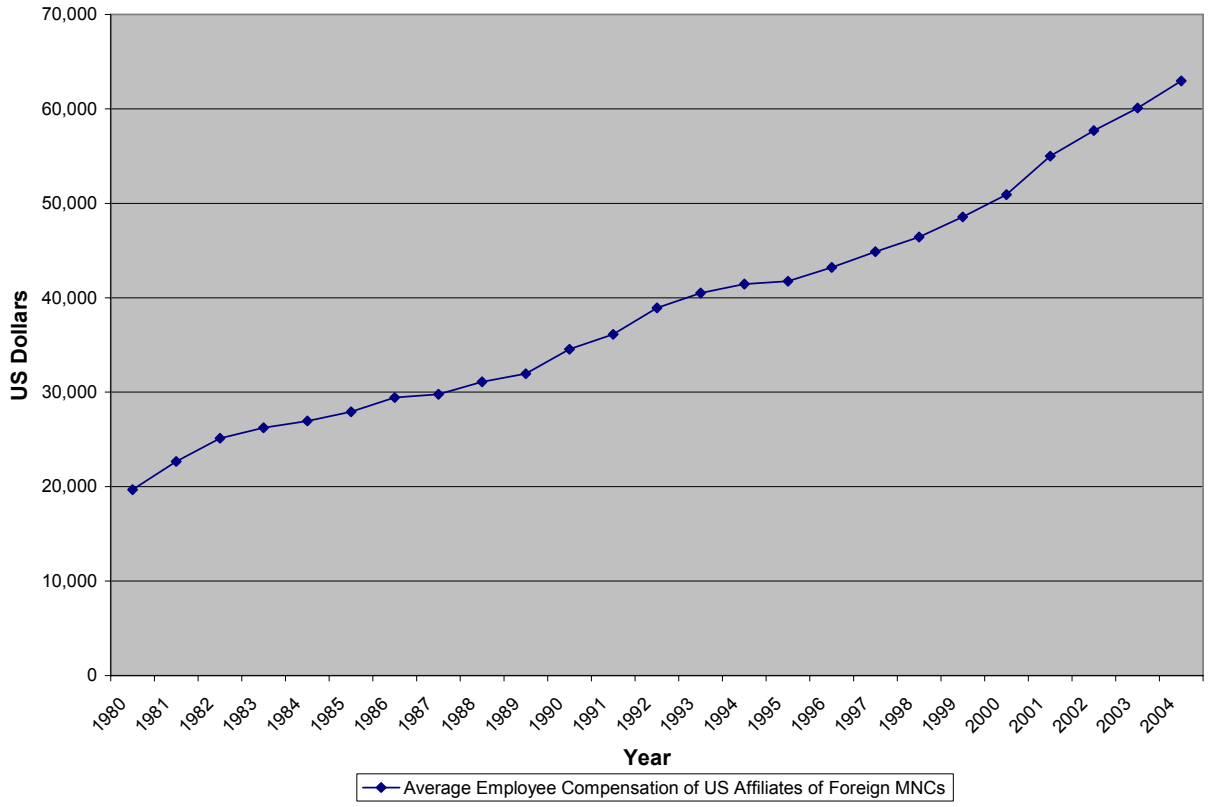
Average employee compensation steadily increased during the period from $20,000 in 1980 to $63,000 in 2004 (See Chart 5-4). This increase in average employee compensation may reflect a shift in the distribution of U.S. affiliate employment between higher paying and lower paying

[163] Economic Report of the President, 2006, Table B-46, p. 336; BLS data.
[164] BEA estimates of U.S affiliate manufacturing employment shares are broken down by industry of sales, a basis that approximates the establishment-based disaggregation of the corresponding data for all U.S. businesses.
[165] Thomas Anderson and William Zeile, *U.S. Affiliates of Foreign Companies: Operations in 2004*, BEA, August 2006, Table 5, p. 201.

industries, changes in the occupational structures due to restructuring within those affiliates to higher paying occupations, increased productivity of workers employed in these U.S affiliates, or a combination of all of these factors.

A change in the industry distribution due to selected sell-offs as the number of these affiliates declined over the period appears to account for some of this. For example, Anderson and Zeile note that most of the foreign sell-offs of U.S. affiliates in 2004 were sell-offs of relatively labor intensive operations.[166] These sold-off labor intensive U.S. affiliate operations were likely to be less able to withstand competition from other more efficient operations. This shrinkage, with an emphasis on improved efficiency, may account for some of the increase in average employee compensation between 2003 and 2004. If similar sell-offs occurred in previous years, this may explain some of the increase shown in Chart 5-4.

Chart 5-4
Average Employee Compensation of Non-Bank U.S. Affiliates of Foreign MNCs
(1980 to 2004)



Source: Bureau of Economic Analysis, B. Operations of U.S. Affiliates of Foreign Companies, Comprehensive Financial and Operating Data.

[166] Anderson and Zeile, *U.S. Affiliates of Foreign Companies*, BEA, 2006, p. 195.

Value Added from U.S. Affiliates of Foreign MNCs Is Increasing

Perhaps the most comprehensive measure of the economic impact of U.S. affiliates of foreign MNCs is their value added since it is included in estimates of GDP. BEA estimates that in 2004 these U.S. affiliates accounted for about $515 billion in current dollar value added—an increase of 8.4 percent over their estimated value added in 2003. This estimated value added in current dollar terms increased steadily since 1988 ($146.4 billion), except for the temporary decline in 2001. The increase in value added for these U.S. affiliates exceeded the overall growth in GDP over the 1988 to 2004 period, but some of this increase reflects foreign acquisitions of existing U.S. assets rather than expanded production among existing or newly established affiliates.[167]

U.S. affiliates of foreign MNCs accounted for an increasing share of U.S. private industry value added over the period—increasing from 3.8 percent in 1988 to 5.7 percent in 2004. Consistent with the decline in the numbers of these U.S. affiliates since their 2000 peak, their current 5.7 percent share of total private sector value added is slightly below the 2000 peak of 5.9 percent. However, the 2004 share has bounced back from the 2001 recession driven decline to 5.4 percent. Because value added includes labor inputs as well as capital and other inputs, these value added trends help explain the increase in U.S. affiliate employment, particularly the increasing share of U.S. manufacturing employment, from in-shoring activities.[168]

BEA value added estimates also indicate that these U.S. affiliates of foreign MNCs are heavily concentrated in manufacturing industries, particularly chemicals and transportation equipment (especially automobiles). The proportion of the total value added for U.S. affiliates from manufacturing industries has declined over the last few years, but by 2004 manufacturing still contributed more than 46 percent of total U.S. affiliate value added.[169]

U.S. AFFILIATED TRADE IN RDT SERVICES

The U.S. policy debate surrounding off-shoring of "white collar," often high paying, services jobs, has recently began to focus on the long-term competitiveness of the United States and the potential consequences of U.S. firms off-shoring RDT[170] activities to their foreign affiliates or to unaffiliated foreign firms. However foreign firms utilizing U.S. RDT services, either through U.S. affiliates or unaffiliated U.S. firms, are often left out of the debate. This analysis covers

[167] The proportion of foreign direct investment in the U.S that simply acquires existing assets and thus represents primarily a change in ownership varies by year.
[168] Anderson and Zeile, *U.S. Affiliates of Foreign Companies*, BEA, 2006, p. 195. BEA staff estimate value added for these U.S. affiliates by summing all input costs (except purchased intermediate inputs) and adding reported profits from their survey data.
[169] Anderson and Zeile, *U.S. Affiliates of Foreign Companies*, BEA, 2006, p. 199
[170] In their surveys, BEA defines RDT services as: "Commercial and noncommercial research, product development services, and testing services. Includes fees for the conduct of experiments or performance of research and development activities aboard spacecraft. Excludes medical and dental laboratory services."

affiliated trade in RDT services within U.S. MNCs, and foreign MNCs with U.S. affiliates[171] in order to better understand the in-shoring effects on U.S. RDT services due to business restructuring.[172]

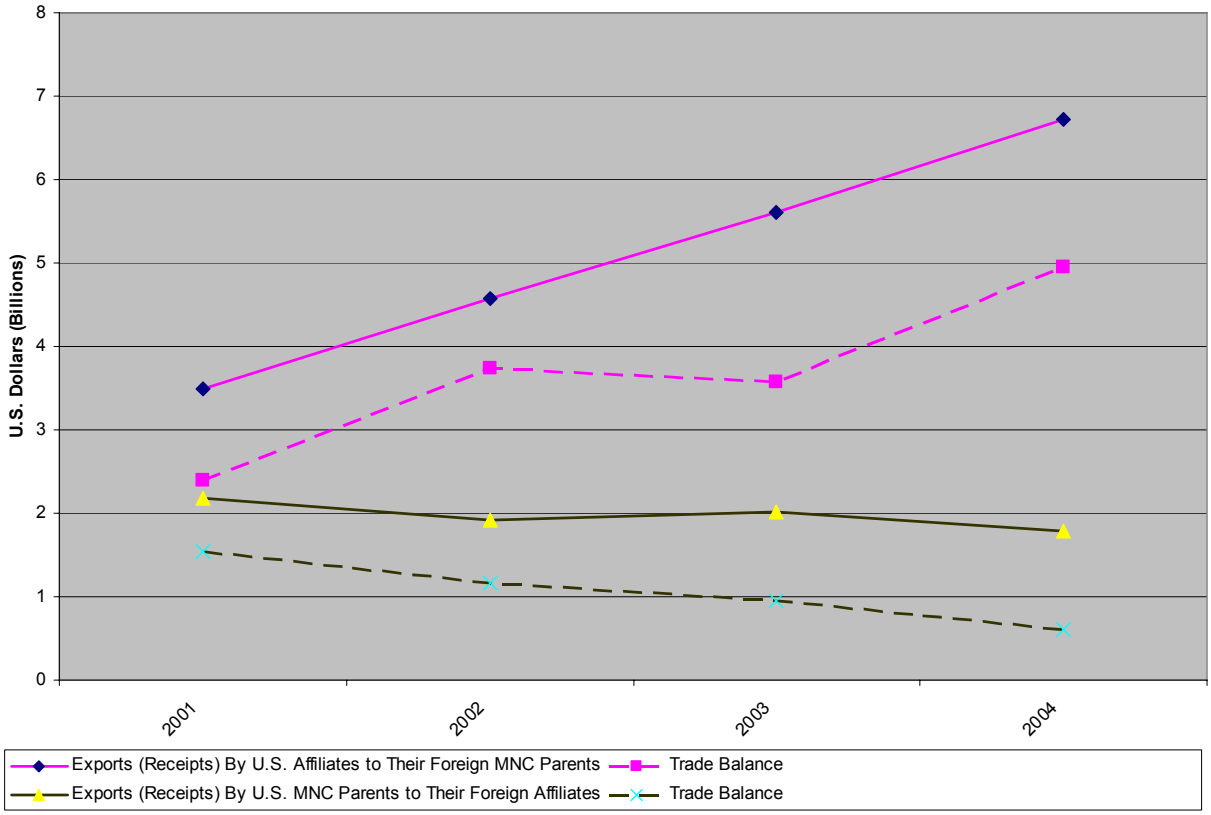
U.S. MNC parent RDT services exports to their foreign affiliates decreased from $2.2 billion in 2001 to $1.8 billion in 2004 (See Chart 5-5). Over the period, RDT services imports from foreign affiliates to their U.S. MNC parents steadily increased from $0.6 billion in 2001 to $1.2 billion in 2004. Although U.S. parent MNCs exported more RDT services to their foreign affiliates than they have imported from their foreign affiliates in all four years, creating a trade surplus, the surplus has steadily decreased from $1.5 billion in 2001 to $0.6 billion in 2004.

U.S. affiliate RDT services exports to their foreign MNC parents substantially increased from $3.5 billion in 2001 to $6.7 billion in 2004. There was no marked trend for U.S. affiliate RDT services imports from their foreign MNC parents from 2001 to 2004, ranging from $0.8 billion to $2.0 billion, respectively. U.S. affiliates exported more RDT services to their foreign MNC parents than they imported during all four years which resulted in trade surpluses that increased from $2.4 billion in 2001 to $5 billion in 2004. These trade surpluses, driven by relatively high exports, were larger than those generated by U.S. MNCs from 2001 to 2004. During the period, foreign MNCs utilized U.S. labor in their U.S. affiliates to produce RDT services for use in their own internal production processes. This suggests that foreign MNCs continue to view the U.S. as a leader in RDT services production and have in turn invested in their U.S. affiliates to obtain access to some of those services in order to improve their own operations. By locating and expanding their affiliate operations in the U.S., foreign MNCs have contributed to the United States' ability to provide RDT services and export them to other nations.

[171] In addition to transactions with its foreign parent, a U.S. affiliate's exports (receipts) and imports (payments) include transactions with other members of its foreign parent group. The foreign parent group is defined as: 1) the foreign parent, 2) any foreign person, proceeding up the foreign parent's ownership chain, that owns more than 50 percent of the foreign person below it, up to and including the ultimate beneficial owner, and 3) any foreign person, proceeding down the ownership chain(s) of each of these members, that is owned more than 50 percent by the person above it.

[172] The data used in this analysis come from BEA quarterly surveys of transactions between U.S. MNC parents and their foreign affiliates, and foreign MNC parents and their U.S. affiliates.

Chart 5-5
U.S. Affiliated Trade in Research, Development and Testing Services Within U.S. and Foreign MNCs (2001 to 2004)



Source: Bureau of Economic Analysis, U.S. International Services: Cross-Border Trade, Table E: Intrafirm Trade in Services, by Type, 1997-2004, http://www.bea.gov/bea/di/1001serv/intlserv.htm.

CONCLUSIONS

Aggregate employment of U.S. affiliates of foreign MNCs substantially increased from 1980 to 2004. By 2004, non-bank U.S. affiliates employed a total of 5.6 million people, a significant contribution to the U.S. labor market. Both manufacturing and services employment of non-bank U.S. affiliates increased from 1980 to 2004. These firms provided more manufacturing jobs in the U.S. during the period than services jobs. However, services employment increased sharply between 1996 and 2000, before declining through 2004. Between 2000 and 2004, the difference between manufacturing and services employment of non-bank U.S. affiliates fell from 214,000 to 163,000 employees. Average employee compensation and value added of non-bank U.S. affiliates (MOUSAs only for value added) also steadily increased from 1980 to 2004.

U.S. MNC parents exported more RDT services to their foreign affiliates, and non-bank U.S. affiliates exported more RDT services to their foreign MNC parents than they imported from 2001 to 2004. The trade surpluses in RDT services for non-bank U.S. affiliates increased from $2.4 billion in 2001 to $5 billion in 2004 and were larger than those generated by U.S. MNC parents for all four years. These results show that foreign MNC parents utilized U.S. labor in

their foreign affiliates to produce RDT services for use in their own internal production processes, reflecting the continued comparative advantage for U.S. RDT services.

These contributions of in-shoring activity to U.S. employment and GDP should not be overlooked when analyzing the economic effects of off-shoring. Trade and foreign direct investment outflows and inflows can both be affected by protectionist policy interventions intended to address only U.S. trade and U.S. foreign direct investment outflows. An unintended consequence of policy interventions to impede future services off-shoring activities by U.S. firms may be the potential decline in U.S. employment from reduced in-shoring activities due to curtailment of foreign direct investment in the U.S. by retaliating foreign governments.

RECOMMENDATION

The Panel recommends that:

- **Policymakers include contributions of in-shoring activity to the United States economy, specifically, employment levels, in any comprehensive assessment of the economic effects of off-shoring.**

PANEL AND STAFF LISTING

PANEL

Janet L. Norwood, *Panel Chair******—Past President and Fellow, American Statistical Association; Fellow, National Association of Business Economists; Honorary Fellow, Royal Statistical Society; Past Vice President and elected member, International Statistical Institute; Counselor and Senior Fellow, Conference Board. Former Senior Fellow, The Urban Institute; U.S. Commissioner of Labor Statistics, U.S. Department of Labor; Research Associate, William L. Clayton Center, Fletcher School of Law and Diplomacy, Tufts University.

Carol Carson—Former Director of the Statistics Department of the International Monetary Fund. Former Director of the Bureau of Economic Analysis of the Department of Commerce; various positions with the Department of Commerce including Deputy Director of BEA, Chief Economist, and Editor-in-Chief of the *Survey of Current Business*; fellow of the National Association of Business Economics; member of the executive committee of the Conference on Research in Income and Wealth.

Manuel Deese*—Managing Partner, Deese, Hastings, & Miller. Former Executive Vice President, Blue Cross and Blue Shield of Virginia; City Manager, Assistant City Manager for Operations, and Assistant City Manager for Administration, City of Richmond, Virginia; Assistant to the City Manager, City of Alexandria, Virginia.

Norman J. Johnson*—Professor/Director, School of Business and Industry, Florida A&M University. Former President and Elected Member, Atlanta School Board; Special Assistant to the Provost, Georgia Institute of Technology; Associate Vice President for Academic Human Resource Development, and Professor of Organizational Effectiveness, Carnegie Mellon University; Associate Dean, Professor of Social Policy, and Chair, M.S. Program, School of Urban and Public Affairs, Carnegie Mellon.

Franklin S. Reeder*—President, The Reeder Group. Former Director, Office of Administration, The White House. Former positions with the U.S. Office of Management and Budget: Deputy Associate Director for Veterans Affairs and Personnel; Assistant Director for General Management and Deputy Assistant Director; Chief, Information Policy Branch and Deputy Chief; Policy Analyst; and Chief, Systems Development Branch. Former Deputy Director, House Information Systems, and Committee Staff, Committee on House Administration, U.S. House of Representatives. Former positions with the U.S. Department of the Treasury and the U.S. Department of Defense focusing on information technology and systems.

John E. Rolph—Professor, University of Southern California, Los Angeles; Founding Head, RAND Statistics Group; faculty positions at the University of London, Columbia University, the RAND Graduate School of Policy Studies, and the RAND/UCLA Health Policy Center; Fellow of the American Statistical Association, the Institute of Mathematical Statistics, the American

Association for the Advancement of Science, and the International Statistical Institute; Chair of the National Research Council's Committee on National Statistics.

STAFF

J. William Gadsby, *Vice President for Academy Studies*—Former Director, Management Studies Program, National Academy of Public Administration. Former positions with the U.S. General Accounting Office: Senior Executive Service; Director, Government Business Operations Issues; Director, Federal Management Issues; Director, Intergovernmental and Management Issues. Former Assistant Director, Financial Management Branch, U.S. Office of Management and Budget.

Terry F. Buss, Ph.D., *Program Area Director*—Former Dean, School of Policy and Management, Florida International University; Policy Director, Community Development and Planning, U.S. Department of Housing and Urban Development; Senior Policy Analyst, Congressional Research Service; Senior Strategy Advisor, World Bank; Senior Policy Advisor, Council of Governors' Policy Advisors; consultant for U.S. Information Service and U.S. Agency for International Development in 10 countries; director of policy research centers at Ohio State, Youngstown State, and University of Akron; director of public management departments at University of Akron and Suffolk University. Two-time Fulbright Scholar—Hungary.

Kenneth F. Ryder Jr., *Project Director*—Served as project director for three other Academy studies on the U.S Park Police, Presidio Trust Corporation, and Patent and Trademark Office. Consultant to the Academy on several other studies and to other federal agencies and entities on a range of economic, financial, banking, housing, budgeting, and financial management issues. Former Senior Executive Service; Executive Director, Research and Analysis, Office of Thrift Supervision; Positions with the U.S. Office of Management and Budget, including Deputy Associate Director, Housing, Treasury and Finance Division, and Deputy Associate Director, Special Studies Division, Economics and Government; Economist, the RAND Corporation

Harry G. Meyers, Ph.D., *Senior Advisor*—Economic and Financial Consultant to the Academy. Former Senior Executive Service; Team Leader, Analytical Consulting Team, U.S. Census Bureau; Chief for Treasury Branch and Commerce and Justice Branch, Office of Management and Budget; Chief and Senior Economist , Special Studies Division, Economics and Government Area OMB. Work at Census and OMB involved statistical analyses of various federal programs and evaluations of major databases. Also served as Senior Analyst for the 1981 President's Housing Commission and as financial economist in the Office of Government Financing in Treasury Department.

Gwyneth H. Caverly, *Senior Research Analyst*—Former Researcher, Global Workforce in Transition, Indefinite Quantity Contract, United States Agency for International Development; Researcher, Center for Economic Policy Analysis—United Nations initiative; and Peace Corps volunteer and administrator.

Jennifer L. H. Blevins, *Senior Research Associate*—Academy projects include wildfire mitigation, National Institutes of Health, and National Marine Fisheries Service. Former Intern in the environment division of the Office of Investment Policy at the Overseas Private Investment Corporation; Former Intern in the Government Relations Office at Defenders of Wildlife. Master's degree in Environmental Policy, American University; Bachelor of Science in Forestry and Wildlife with a concentration in wildlife science, Virginia Tech.

Noel A. Popwell, *Senior Research Associate*—Former Program /Budget Analyst, Federal Reserve Board; former Budget/Management Analyst, City of Alexandria, Virginia; Master of Public Administration, American University; Bachelor of Arts in Economics, Hunter College, New York.

Martha S. Ditmeyer, *Senior Program Associate*—Former staff member of the Massachusetts Institute of Technology and of the Communications Satellite Corporation, Washington, D.C. and Geneva, Switzerland.

INDIVIDUALS INTERVIEWED OR CONSULTED

FEDERAL AGENCIES

Department of Commerce
Kathleen Cooper, Undersecretary for Economic Affairs

Office of Technology Policy
Ben Wu, Assistant Secretary for Technology Policy
Daniel Caprio, Deputy Assistant Secretary for Technology Policy
Connie Chang, Acting Director
Mark Boroush, Policy Analyst
Laureen Daly, Policy Analyst
Douglas Devereaux, Policy Analyst
John Sargent, Senior Policy Analyst

Bureau of the Census
Hermann Habermann, Deputy Director and Chief Operating Officer
Thomas Mesenbourg, Assistant Director for Economic Programs
Ronald H. Lee, Senior Financial Advisor, Office of the Associate Director
Daniel Weinberg, Chief Economist, Center for Economic Studies

Bureau of Economic Analysis
Steve Landefeld, Director
Rosemary Marcuss, Deputy Director
Ralph Kozlow, Associate Director for International Economics
Obie Whichard, Chief, International Investment Division
Ned Howenstine, Chief, Research Branch, International Investment Division
Patricia Aboroa, Special Assistant to the Associate Director for International Economics
Jiemin Guo, Senior Economist, Industrial Accounts
Maria Borga, Research Branch, International Investment Division
Ray Mataloni, Research Branch, International Investment Division
William Zeile, Research Branch, International Investment Division
Mark Planting, Chief, Annual Input-Output Branch, Industrial Accounts
Robert Yuskavage, Industrial Accounts
Gabriel Medeiros, Annual Input-Output Branch, Annual Input-Output Branch

Economics and Statistics Administration
Patricia Buckley, Senior Policy Advisor
Keith Hall, Chief Economist

International Trade Administration
David Long, Director, Office of Service Industries
Sara Hagigh, International Trade Specialist, Office of Service Industries

Department of Homeland Security

Office of Immigration Statistics
Michael D. Hoefer, Director
Elizabeth M. Grieco, Senior Analyst

Office of the Inspector General
Douglas Ellice, Chief Inspector

Department of Labor

Bureau of Labor Statistics
Kathleen Utgoff, Commissioner
Phil Rones, Acting Commissioner
Sharon P. Brown, Chief, Local Area Unemployment Statistics
Richard Clayton, Chief, Division of Administrative Services
James Franklin, Supervisory Economist, Office of Employment Projections
John M. Galvin, Associate Commissioner for Employment and Unemployment Statistics
Pat Getz, Assistant Commissioner, Office of Industry Employment Statistics
Cheryl Kerr, Economist, Office of the Commissioner
Mike Pilot, Chief, Division of Occupational Outlook
Norman Saunders, Senior Economist, Office of Employment Projections
James Spletzer, Senior Research Economist, Office of Employment and Unemployment Statistics
George D. Stamas, Division Chief, Occupational Employment Statistics

Employment and Training Administration
Gardner Carrick, Communications Director
Terry Clark, Assistant to the Trade Adjustment Assistance Division Director
Wayne Gordon, Team Leader, Office of Policy Development and Research
Jacqui Shoholm, Director, Division of Policy and Legislation
Kimberly Vitelli, Manpower Analyst

Department of State

Bureau of Consular Affairs
Lorraine Lewis, Non-immigrant Visa Reporting and Control Office

Department of the Treasury

Office of Thrift Supervision
Scott Albinson, Managing Director for Supervision
Donna Deale, Assistant Managing Director, Examination and Supervision Policy
Robert Engelbreth, Director, Information Technology Risk

INDEPENDENT AGENCIES

Congressional Research Service
Mary Jane Bolle, Analyst, Foreign Affairs, Defense and Trade Division

General Accountability Office
Virginia Hughes, Assistant Director, International Affairs and Trade
Bradley Hunt, Analyst
Judith Knepper, Project Manager, International Affairs and Trade
Loren Yeager, Director, International Affairs and Trade

International Trade Commission
Richard Brown, Chief, Services and Investment Division
Michael Ferrentino, Economist
Eric Forden, International Trade Analyst

National Academy of Sciences
Connie Citro, Director of the Committee on National Statistics
Jane Ross, Director, Center for Social and Economic Studies
Michael Moloney, Program Officer, National Research Council

National Science Foundation
Jacqueline Meszaros, Director, Division of Social and Economic Sciences
Mark Regets, Senior Analyst

Office of Management and Budget
Katherine Wallman, Chief Statistician
Paul Bugg, Desk Officer

Office of the U.S Trade Representative
David Walters, Assistant U.S. Trade Representative for Economic Affairs

Social Security Administration
Joyce Manchester, Director**,** Division of Economic Research**,** Office of Policy

US China Commission
Thomas Palley, Chief Economist

UNITED STATES SENATE

Office of Senator Joseph Lieberman
Paul Brand, Legislative Fellow

BUSINESS GROUPS

Business Roundtable
Chuck Levy, Consultant

Chamber of Commerce
Brian Josten, Executive Vice President, Government Affairs
Martin Regalia, Vice President for Economic and Tax Policy

National Association of Manufacturers
David Huether, Chief Economist
Patricia Long, Vice President of Advocacy and Policy Research

INTERNATIONAL ORGANIZATIONS

International Monetary Fund
Neil Patterson, Assistant Director, Balance of Payments and External Debt Division
Mary Amiti, Research Department
John Motala, Senior Economist

Organization for Economic Co-operation and Development
Nobuo Tanaka, Director, Science, Technology and Industry
Desiree van Welsum
Graham Vickery
Dirk Pilat

Statistics Canada
Yvan Gervais, Coordinator, Research and Analysis, Business and Trade Statistics Field
Pier-Paul Proulx, Senior Research Advisor, Policy Research Initiative
Arthur Ridgeway, Director, Balance of Payments Division
Jean-Pierre Simard, Services Division
Ted Wannell, Labour and Household Surveys Analysis Division
Gary Sawchuk, Policy Research Initiative
Rene Morissette, Business and Labour Market Analysis Division
Sebastien LaRochelle-Cote, Business and Labour Market Analysis Division

Industry Canada
Prakash Sharma

International Trade Canada
Shenjie Chen
David Dodds

OFF-SHORING VENDORS

Agilent Technologies
Anita Manwani, Former Vice President

GTL Limited
Michael T. Clark, CEO and President

International Association of Outsourcing Professionals
Mike Corbett, Executive Director

neo-IT
Atul Vashista, Chief Executive Officer

PRIVATE RESEARCH GROUPS

EvalueServe
Alok Aggarwal, CEO

Forrester Research
John McCartney, Vice President

Global Insight
Nariman Behravesh, Chief Economist

McKinsey Inc
Diane Farrell, Director of Research
Martha Laboissiere

National Bureau of Asian Research
Joyce Noonan, Assistant Director for Globalization Programs

National Opinion Research Center
Julia Lane, Senior Vice President and Director, Economics, Labor and Population Studies

THINK TANKS

American Enterprise Institute
Kevin Hassett, Director of Economic Policy Studies

Economic Policy Institute
Josh Bivens, Economist
Lee Price, Research Director
Robert Scott, Economist

Institute for International Economics
Martin Baily, Senior Fellow
Bradford Jensen, Deputy Director
Catherine Mann, Senior Fellow
Jacob Kirkegaard, Research Associate

Woodrow Wilson Center
Kent Hughes, Director, Project on America and the Global Economy
Lynn Sha, Program Associate

TRADE ASSOCIATIONS

American Council on International Personnel
Lynn Shotwell, Executive Director

Association for Computing Machinery
Cameron Wilson, Director

American Electronics Association
Josh James, Manager of Research
Matthew Kazmierczak, Director of Research

Council on Competitiveness
David Attis, Director, Policy Studies

Information Technology Association of America
Jeffrey Lande, Senior Vice President

Institute of Electrical and Electronics Engineers
Russell Harrison, Legislative Representative, Grassroots Activities
Vin O'Neill, Legislative Representative

UNIONS

American Federation of Labor-Congress of Industrial Organizations
Paul Almeida, President
Ronald Blackwell, Chief Economist
Michael Gildea, Executive Director
Thea Lee, Assistant Director for International Economics
WashTech/CWA
Marcus Courtney, President

UNIVERSITIES

Carnegie Mellon University

Ashish Arora, Associate Professor

Georgetown University
Robert Bednarzik, Visiting Professor, Public Policy Institute
Lindsay Lowell, Professor

Johns Hopkins University
Burt Barnow, Associate Director for Research, Institute for Public Policy Studies

Indiana University
William Aspray, Professor of Informatics

Massachusetts Institute of Technology
Tim Sturgeon, Senior Research Affiliate, Industrial Performance Center

Rochester Institute of Technology Policy
Ron Hira, Assistant Professor

Stanford University
Rafiq Dossani, Senior Research Scholar, Asia-Pacific Research Center
Eric Roberts, Professor

University of California, Berkeley
Cynthia Kroll, Researcher

University of California, Davis
Martin Kenney, Professor

University of Dartmouth
Matthew Slaughter, Associate Professor

University of Maryland
John Haltiwanger, Professor
Jeff Werling, President, InForum

WE Upjohn Institute
Susan Houseman, Senior Economist

APPENDIX C

SELECTED BIBLIOGRAPHY

Abowd, John M., John Haltiwanger, and Julia Lane. "Integrated Longitudinal Employee-Employer Data for the United States." *American Economic Review* 94 (2) (May 2004): 224-229.

Abowd, John M., Paul Lengermann, and Kevin L. McKinney. "The Measurement of Human Capital in the U.S. Economy." March 2003.

AFL-CIO. "The Bush Record on Shipping Jobs Overseas." Washington, D.C.: AFL-CIO, 2004.

_____. "Corporate Myths about Shipping Jobs Overseas." 2005. Available at http://www.aflcio.org/yourjobeconomy/jobs/outsourcing_myths.cfm.

_____. "Corporations Doubled the Number of Jobs Sent Overseas in Three Years." Washington D.C.: AFL-CIO, 2004. <http://www.aflcio.org/yourjobeconomy/jobs/ns10202004.cfm>.

_____. "Crisis in Manufacturing." Washington, D.C.: AFL-CIO, 2004.

_____. "Declining Job Quality: Here to Stay?" Washington, D.C.: AFL-CIO, 2004.

_____. "Outsourcing America." Washington, D.C.:AFL-CIO, 2004.

_____. "Shipping Jobs Overseas: How Real Is the Problem?" Washington, D.C.: AFL-CIO, 2005.

Agarwal, Pawan. "Higher Education in India: The Need for Change." ICRIER Working Paper no. 180. New Delhi: Indian Council for Research on International Economic Relations, 2006.

Aggrawal, Swati, Terry Levine, and Brian Jennings. "Outsourcing: Perspectives and its Economic Impact." Presentation. 2005.

Agrawal, Vivek and Diana Farrell. "Who Wins in Offshoring." *The McKinsey Quarterly, 2003 Special Edition: Global Directions* (2003).

Agrawal, Vivek, Diana Farrell, and Jaana K. Remes. "Offshoring and Beyond." *The McKinsey Quarterly, 2003 Special Edition: Global Directions* (2003).

Ahearn, Raymond J. "U.S.-European Union Trade Relations: Issues and Policy Challenges." IB10087. Washington, D.C.: Congressional Research Service, March 2003.

Ahn, Sanghoon, Dongheon Lee, Siwook Lee, and Cheonsik Woo. "The Economic Impacts of Outbound FDI and Trade: The Case of Korea." Presented at the OECD Conference. Paris, France, November 2005.

Allegretto, Sylvia, Jared Bernstein, and Isaac Shapiro. "The Lukewarm 2004 Labor Market: Despite Some Signs of Improvement, Wages Fell, Job Growth Lagged, and Unemployment Spells Remained Long." Washington, D.C.: Economic Policy Institute, February 2005.

American Association for the Advancement of Science. "Trends in Federal Research by Discipline, FY 1976-2004." <http://www.aaas.org/spp/rd/discip04c.pdf>

American Enterprise Institute for Public Policy Research. "Polls on NAFTA: A 10-Year Review." AEI, December 2003.

_____. "Summary: Domestic Effects of Foreign Direct Investment." AEI Conference on *Domestic Effects of Foreign Direct Investment*, 2 December 2004. 28 April 2005 <http://www.aei.org/events/filter.,eventID.957/summary.asp>.

Amiti, Mary and Shang-Jin Wei. "Fear of Service Outsourcing: Is it Justified?" WP/04/186. Washington, D.C.: International Monetary Fund, October 2004. Presented at the OECD Conference. Paris, France, November 2005.

_____. "Service Offshoring, Productivity, and Employment: Evidence from the United States" WP/05/238. Washington, D.C.: International Monetary Fund, December 2005. Presented at the Conference on International Service Flows. Bethesda, MD, April 2006.

Anderson, Thomas and William Zeile. *U.S. Affiliates of Foreign Companies: Operations in 2004*. Washington, D.C.: U.S. Bureau of Economic Analysis, August 2006.

Andersson, Fredrik, Harry J. Holzer and Julia I. Lane, "Moving Up or Moving On: Who Advances in the Low-Wage Labor Market." New York: Russell Sage Foundation, 2005

Antrás, Pol and Elhanan Helpman. "Global Sourcing." *Journal of Political Economy* 112 (3) (June 2004): 552-580.

Antrás, Pol, Luis Garicano, and Esteban Rossi-Hansberg. "Offshoring in a Knowledge Economy." Cambridge, MA: National Bureau of Economic Research, January 2005.

Arora, Ashish. "From Underdogs to Tigers: The Emerging Offshore Software Industries and the US Economy." Presentation at Brookings Trade Forum *Offshoring White-Collar Work – The Issues and the Implications*, 12-13 May 2005.

Aspray, William, Frank Mayadas, and Moshe Y. Vardi, eds. *Globalization and Off-shoring of Software*. A Report of the ACM Migration Task Force (ACM 0001-0782/06/0200). New York: Association for Computing Machinery, 2006.

A.T. Kearney. A.T. Kearney's 2004 Offshore Location Attractiveness Index: Making Offshore Decisions. Chicago: A.T. Kearney, Inc., 2004.

Atkinson, Robert. "Meeting the Offshoring Challenge." Washington, D.C.: Progressive Policy Institute, July 2004.

____. "Understanding the Offshoring Challenge." Washington, D.C.: Progressive Policy Institute, May 2004.

Aubert, Patrick and Patrick Sillard. "Offshoring and Job Losses in French Industry." Series of working papers of the Directorate for Economic Studies and Analysis: April 2005. Presented at the OECD Conference. Paris, France, November 2005.

Baily, Martin N. and Diana Farrell. "Exploding the Myths about Offshoring." McKinsey Global Institute, April 2004.

Baily, Martin Neil and Robert Z. Lawrence. "Don't Blame Trade for U.S. Job Losses." *The McKinsey Quarterly* 1 (2005).

_____. "What Happened to the Great US Job Machine? The Role of Trade and Electronic Offshoring." *Brookings Papers on Economics Activity* 2 (2004).

Bain, Olga, Dao T. Luu, and Madeleine F. Green. "Students on the Move: The Future of International Students in the United States." *ACE Issue Brief* (October 2006). Washington, D.C.: American Council on Education.

Balaker, Ted, and Adrian T. Moore. "Offshoring and Public Fear: Assessing the Real Threat to Jobs." Reason Foundation, May 2005.

Balasubramanian, Ramnath and Asutosh Padhi. "The Next Wave in US Offshoring." *The McKinsey Quarterly* 1 (2005).

Bardhan, Ashok Deo and Dwight Jaffee. "On Intra-Firm Trade and Multinationals: Foreign Outsourcing and Offshoring in Manufacturing." University of California, April 2004.

Bardhan, Ashok Deo and Cynthia A. Kroll. "The New Wave of Outsourcing." *Research Report, Fisher Center for Real Estate and Urban Economics—University of California* (2003).

Barfield, Claude. *High-Tech Protectionism: The Irrationality of Antidumping Laws*. Washington, D.C.: AEI Press, 2003.

Barnow, Burt S. and Christopher T. King. "The Workforce Investment Act in Eight States." Washington, D.C.: U.S. Department of Labor, February 2005.

Barry, Frank and Desiree van Welsum. "Services FDI and Offshoring into Ireland." Paper prepared for the OECD Directorate for Science, Technology and Industry Panel Session on Offshoring, 9-10 June 2005.

Bartelsman, Eric, Stefano Scarpetta, and Fabiano Schivardi. "Comparative Analysis of Firm Demographics and Survival: Micro-Level Evidence for the OECD Countries." Paris: Organisation for Economic Co-operation and Development, 2003.

Batalova, Jeanne. "Competing for Global Talent: The Race Begins with Foreign Students." *Immigration Policy In Focus* 5(7) September 2006.

Batt, Rosemary, Virginia Doellgast, and Hyunji Kwon. "A Comparison of Service Management and Employment Systems Among In-house, Outsourced, and Offshore Call Centers." Paper prepared for the Brookings Trade Forum *Offshoring White-Collar Work –The Issues and Implications*, Washington, D.C., 12-13 May 2005.

Bayoumi, Tamin, and Marcus Haacker. "It's Not What You Make, It's How You Use It: Measuring the Welfare Benefits of the IT Revolution Across Countries." Discussion Paper 3555. London: Centre for Economic Policy Research, September 2002.

Becker, Sascha O., Karolina Ekholm, Robert Jackle, and Marc-Andreas Muendler. "Location Choice and Employment Decisions: A Comparison of German and Swedish Multinationals." August 2005. Presented at the OECD Conference. Paris, France, ... November 2005.

Bednarzik, Robert, and Brett Theodos. "U.S. Services Trade, Employment, and Competitiveness." NBR Analysis, National Bureau of Asian Research 17 (5) December 2006.

Benedetto, Gary, et al. "Using Worker Flows to Measure Firm Dynamics." Washington, D.C.: U.S. Census Bureau, May 2004.

Bergmann, Markus, Ramesh Mangaleswaran, and Glenn A. Mercer. "Global Sourcing in the Auto Industry." *The McKinsey Quarterly, 2004 Special Edition: China Today* (2004).

Bergsten, C. Fred, and the Institute for International Economics. "The United States and the World Economy: Foreign Economic Policy for the Next Decade." Washington, D.C.: Institute for International Economics, January 2005.

Berman, Jay M. "Industry Output and Employment Projections to 2012." *Monthly Labor Review* (February 2004): 58-79.

Bernard, Andrew B., J. Bradford Jensen, and Peter K Schott. "Falling Trade Costs, Heterogeneous Firms, and Industry Dynamics." March 2004.

_____. "Importers, Exporters and Multinationals: A Portrait of Firms in the U.S. that Trade Goods." April 2005.

Bhagwati, Jagdish, Arvind Panagariya, and T.N. Srinivasan. "The Muddles over Outsourcing." *The Journal of Economic Perspectives* 18(4) (Fall 2004): 93-114.

_____. "Why Your Job Isn't Moving to Bangalore." Washington, D.C.: American Enterprise Institute for Public Policy Research, March 2004.

Bivens, Josh. "Shifting Blame for Manufacturing Job Loss: Effect of Rising Trade Deficit Shouldn't be Ignored." Washington D.C.: Economic Policy Institute, undated.

_____. "EPI Issue Guide—Off-shoring." Washington, D.C.: Economic Policy Institute, Updated May 2006.

_____. "Truth and Consequences of Off-shoring." An EPI Briefing Paper. Washington, D.C.: Economic Policy Institute.

Blinder, Alan S. "Fear of Off-shoring." Center for Economic Policy Studies Working Paper #119. Princeton University, Dec 2005

Boehner, Rep. John A. and Rep. Howard P. "Buck" McKeon. "The College Cost Crisis: A Congressional Analysis of College Costs and Implications for America's Higher Education System." September 4, 2003.

Borga, Maria. "Trends in Employment at U.S. Multinational Companies: Evidence from Firm-Level Data." Paper presented at the Brookings Trade Forum *Offshoring White-Collar Work—The Issues and Implications*, Washington, D.C., 12-13 May 2005.

_____. "Addressing Selected Issues in U.S. Bureau of Economic Analysis Estimates of U.S. International Services: Improved Measures of Insurance, Wholesale and Retail Trade, ... and Financial Services." Washington, D.C.: U.S. Bureau of Economic Analysis. Presented at the Conference on International Service Flows. Bethesda, MD, April ..... 2006.

Borga, Maria and Michael Mann. "Cross-Border Trade in 2002 and Sales Through Affiliates in 2001." *Survey of Current Business* (October 2003): 58-118.

____. "Cross-Border Trade in 2003 and Sales Through Affiliates in 2002." *Survey of Current Business* (October 2004): 25-76.

Borga, Maria and William J. Zeile. "International Fragmentation of Production and the Intrafirm Trade of U.S. Multinational Companies." WP2004-02. Washington, D.C.: U.S. Bureau of Economic Analysis, January 2004.

Borjas, George J. "Do Foreign Students Crowd Out Native Students from Graduate Programs?" National Bureau of Economic Research Working Paper No. 10349. Cambridge, MA: 2004.

_____. "The Labor Market Impact of High-Skill Immigration." Cambridge, MA: National Bureau of Economic Research, March 2005.

Bottino, Susan J. "Perspective on Offshoring and New Jersey." Trenton, N.J.: New Jersey Policy Perspective, August 2004.

Boulhol, Herve and Lionel Fontagné. "Deindustrialisation and the fear of relocations in the industry." 13 July 2005. Presented at the OECD Conference. Paris, France, November 2005.

Brainard, Lael and Robert E. Litan. "'Offshoring' Service Jobs: Bane or Boon—and What to Do?" *The Brookings Institution Policy Brief #132* (April 2004).

Brainard, Lael, Robert E. Litan, and Nicholas Warren. "A Fairer Deal for America's Workers in a New Era of Offshoring." Paper presented at the Brookings Trade Forum *Offshoring White-Collar Work–The Issues and Implications,* Washington, D.C., 12-13 May 2005.

Brandt, Nicola. "Business Dynamics in Europe." Paris: Organisation for Economic Co-operation and Development, 2004.

_____. "Business Dynamics, Regulation and Performance." Paris: Organisation for Economic Co-operation and Development, 2004.

Bronfenbrenner, Kate. "Uneasy Terrain: The Impact of Capital Mobility on Workers, Wages, and Union Organizing." Submitted to the U.S. Trade Deficit Review Commission, September 2000.

Bronfenbrenner, Kate and Stephanie Luce. "The Changing Nature of Corporate Global Restructuring: The Impact of Production Shifts on Jobs in the US, China, and Around the Globe." Washington, D.C.: U.S.-China Economic and Security Review Commission, October 2004.

Brown, Clair, John Haltiwanger, and Julia Lane. "Economic Turbulence: Is a Volatile Economy Good for America?" Chicago: University of Chicago Press, 2006.

Brown, Clair and Greg Linden. "Offshoring in the Semiconductor Industry: A Historical Perspective." Prepared for the 2005 Brookings Trade Forum *Offshoring of White-Collar Work—the Issues and Implications*, Washington, D.C., 12-13 May 2005.

Brown, Sharon P. "Mass Layoff Statistics and Domestic and Overseas Relocation." Presented at the Brookings Institution *Data Workshop on Offshoring*, Washington, D.C., June 2004.

_____. "Mass Layoff Statistics Data in the United States and Domestic and Overseas Relocation." Presented at the EU-US Seminar on *Offshoring of Services in ICT and Related Services,* Brussels, Belgium, 13-14 December 2004.

Brown, Sharon P. and James Spletzer. "Labor Market Dynamics Associated with the Movement of Work Overseas." Washington, D.C.: U.S. Bureau of Labor Statistics, 2 November, . 2005. Presented at the OECD Conference. Paris, France, November 2005.

Buchholz, Todd G. "Bringing the Jobs Home: How the Left Created the Outsourcing Crisis—and How We Can Fix It." New York: Penguin Group, 2004.

Bulkeley, William M. "IBM Documents Give Rare Look at Sensitive Plans on 'Offshoring.'" *Wall Street Journal* (January 19, 2004).

Business Cycle Dating Committee. "The Business-Cycle Peak of March 2001." Washington, D.C.: National Bureau of Economic Research, November 26, 2001. 18 May 2006 <http://www.nber.org/cycles/november2001/>

Business Cycle Dating Committee. July 17 Meeting Report. 18 May 2006 <http://www.nber.org/cycles/july2003.html>

Business Roundtable. "Economic Growth and Job Creation: What Do Americans Think?" Washington, D.C.: Undated.

_____. "How to Secure U.S. Economic Growth and Jobs in the Worldwide Economy." Washington, D.C.: Undated.

_____. "Securing Growth and Jobs: Improving U.S. Prosperity in a Worldwide Economy." Washington, D.C.: March 2004.

Cato Institute. Cato Handbook for Congress: Policy Recommendations for the 108th Congress. Washington, D.C.: Cato Institute, undated.

Choy, Susan P. and Xiaojie Li. "Debt Burden: A Comparison of 1992-93 and 1999-2000 Bachelor's Degree Recipients a Year After Graduating" (NCES 2005–170), U.S. Department of Education, National Center for Education Statistics. Washington, D.C.: U.S. Government Printing Office, 2005.

Clark, Kelly A. and Rosemary Hyson. "New Tools for Labor Market Analysis: JOLTS." *Monthly Labor Review* (December 2001).

Clausing, Kimberly. "The Role of U.S. Tax Policy in Offshoring." Presented at the Brookings Trade Forum *Offshoring of White-Collar Work—the Issues and Implications,* Washington, D.C., 12-13 May 2005.

Commission on Professionals in Science and Technology. *STEM Workforce Data Project: Report #1: Twenty Years of Scientific and Technical Employment*. Washington, D.C.: 2004.

Committee on Policy Implications of International Graduate Students and Postdoctoral Scholars in the United States, Board on Higher Education and Workforce, National Research Council. *Policy Implications of International Graduate Students and Postdoctoral Scholars in the United States*. Washington, D.C.: National Academy of Sciences, 2005.

Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology. *Rising Above The Gathering Storm: Energizing and Employing America for a Brighter Economic Future*. Washington, D.C.: National Academy of Sciences, 2006.

"Companies that Outsource Offshore According to Lou Dobbs."

Computer Systems Policy Project. "Choose to Compete: How innovation, investment and productivity can grow U.S. jobs and ensure American competitiveness in the 21st century." Washington, D.C.: January 2004.

_____. "Ten Common Myths about Worldwide Sourcing." Washington, D.C.: undated.

Corrado, Carol, Paul Lengermann and Larry Slifman. "The Contribution of MNCs to U.S. Productivity Growth, 1977-2000." Federal Reserve Board, Washington, D.C. October 2003 (Revised July 18, 2005). Presented at the Conference on International Service Flows. Bethesda, MD, April 2006.

Council of Graduate Schools. "Findings from the 2006 CGS International Graduate Admissions Survey, Phase I: Applications." Washington, DC: March 2006.

_____. "Findings from the 2006 CGS International Graduate Admissions Survey, Phase III: Admissions and Enrollment." Washington, DC: October 2006.

Council on Competitiveness. "Competitiveness Index: Where America Stands." Washington, D.C.: November 2006.

Cowen, Tyler. "Creative Destruction: How Globalization is Changing the World's Cultures." Princeton and Oxford: Princeton Press, 2004.

Craig, David and Paul Willmott. "Outsourcing Grows Up." *The McKinsey Quarterly* (February 2005).

Criscuolo, Chiara and Mark Leaver. "Offshore Outsourcing and Productivity." Presented at the OECD Conference. Paris, France, November 2005.

Davis, Steven J., John C. Haltiwanger, and Scott Schuh. "Job Creation and Destruction." Cambridge, MA, and London, England: MIT Press, 1997.

Deloitte Consulting. "Calling a Change in the Outsourcing Market: The Realities for the World's Largest Organizations." Deloitte Development LLC, April 2005.

Deloitte Research. "Business in China, the Next Stage: The Fifth Modernization." Deloitte Touche Tohmatsu, 2005.

_____. "The Cusp of a Revolution: How Offshoring will Transform the Financial Services Industry." Deloitte Consulting, 2003.

_____. "Inside Outsourcing: The what, who, and how of outsourcing IT-intensive processes." Deloitte Consulting, 2003.

_____. "The Macro-Economic Case for Outsourcing." Deloitte Consulting, 2003.

_____. "Making the Off-Shore Call: The Road Map for Communications Operators." Deloitte Touche Tohmatsu, 2004.

_____. "The Titans Take Hold: How offshoring has changed the competitive dynamic for global financial services institutions." Deloitte Development LLC, 2004.

Desai, Mihir A., C. Fritz Foley, and James R. Hines, Jr. "Chains of Ownership, Regional Tax Competition, and Foreign Direct Investment." Working paper 9224. Cambridge, MA: National Bureau of Economic Research, 2002.

_____. "Foreign Direct Investment and Domestic Economic Activity." Presentation, AEI Conference on *Domestic Effects of Foreign Direct Investment*, 2 December 2004.

_____. "International Joint Ventures and the Boundaries of the Firm." Working paper 9115. Cambridge, MA: National Bureau of Economic Research, 2002.

"Distortions and Deceptions in Strategic Decisions." The McKinsey Quarterly. 1st Edition. New York: McKinsey and Company, 2006.

Division of Research, Evaluation, and Communication, Directorate for Education and Human Resources. *Indicators of Science and Mathematics Education 1995* (NSF 96-52), edited by Larry E. Suter. Arlington, VA: National Science Foundation, 1996.

Dobbs, Lou. "Exporting America: Why Corporate Greed is Shipping American Jobs Overseas." New York and Boston: Warner Business Books, 2004.

Doig, Stephen J., et al. "Has Outsourcing Gone Too Far?" *The McKinsey Quarterly* 4 (2004).

Dossani, Rafiq. "Globalization and the Outsourcing of Services: The Impact of Indian Offshoring." In *Offshoring White-Collar Work—The Issues and Implications*, *The Brookings Trade Forum, 2005,* edited by Lael Brainard and Susan M. Collins. Washington, D.C.: The Brookings Institution, forthcoming.

Dossani, Rafiq and Martin Kenney. "Went for Cost, Stayed for Quality? Moving the Back Office to India." December 2003.

Dryburgh, Heather, and Jason Hamel. "Immigrants in Demand: Staying or Leaving?" Statistics Canada, *Canadian Social Trends* (Autumn 2004): 12-17.

Dudley, Bill, et al. "Offshoring: Where Have all the Jobs Gone?" Goldman Sachs, *US Economics Analyst* 3/38 (19 September 2003).

Economic Report of the President. Washington, DC: U.S. Government Printing Office, 2006.

Eurostat Progress Report to the Voorburg Group, September 23, 2003. Presented at 18th Meeting of the Voorburg Group, Tokyo, Japan, October 2003.

Faberman, R. Jason. "Gross Job Flows Over the Past Two Business Cycles: Not all 'Recoveries' are Created Equal." Working paper 372. Washington, D.C.: U.S. Bureau of Labor Statistics, June 2004.

Farrell, Diana, Sacha Ghai, and Tim Shavers. "A Silver Lining in the US Trade Deficit." *The McKinsey Quarterly* (March 2005).

Farrell, Diana and Adil S. Zainulbhai. "A Richer Future for India." *The McKinsey Quarterly, 2004 Special Edition: What Global Executives Think* (2004).

Farrell, Diana, *et al. The Emerging Global Labor Market*. McKinsey Global Institute, 2005.

Farrell, Diana, et al. *The Emerging Global Labor Market: Part II—The Supply of Offshore Talent in Services.* McKinsey Global Institute, 2005.

Feenstra, Robert C. and Gordon H. Hanson. "Global Production Sharing and Rising Inequality: A Survey of Trade and Wages." Working paper 8372. Cambridge, MA: National Bureau of Economic Research, June 2001.

_____. "The Impact of Outsourcing and High-Technology Capital on Wages: Estimates for the United States, 1979-1990." *The Quarterly Journal of Economics* 114 (3) (August 1999): 907-940.

Finn, Michael G. "Stay Rates of Foreign Doctorate Recipients from U.S. Universities, 2003." Oak Ridge Institute for Science and Education, November 2005.

Florida, Richard. "The Rise of the Creative Class…and how it's transforming work, leisure, community, & everyday life." New York: Basic Books, 2002.

Feliciano, Zadia and Robert E. Lipsey. "Foreign Entry into U.S. Manufacturing by Takeovers and the Creation of New Firms." Working paper 9122. Cambridge, MA: National Bureau of Economic Research, September 2002.

Freeman, Richard B. "Does Globalization of the Scientific/Engineering Workforce Threaten US Economic Leadership?" Prepared for *Innovation Policy and the Economy Conference,* Washington, D.C., 19 April 2005.

_____. "Doubling the Global Work Force: The Challenge of Integrating China, India, and the Former Soviet Bloc into the World Economy." Washington, D.C.: Institute for International Economics, November 2004.

Fung, K.C., Lawrence J. Lau, and Joseph S. Lee. "General Characteristics of U.S. Direct Investment." In *U.S. Direct Investment in China.* Washington, D.C.: American Enterprise Institute, 2004.

Gareiss, Robin. "Analyzing the Outsourcers." *Information Week* (November 18, 2002).

Garner, C. Alan. "Offshoring in the Service Sector: Economic Impact and Policy Issues." Federal Reserve Bank of Kansas City, *Economic Review* (Third Quarter 2004): 5-37.

Gereffi, Gary et al. "Framing the Engineering Outsourcing Debate: Placing the United States on a Level Playing Field with China and India." Duke University's Master of Engineering Management Program, 2005.

Glassman, James K. and Kevin A. Hassett. "Understanding the Role of the United States in the Global Economy." Washington, D.C.: AEI, August 2003.

Global Insight. "Executive Summary: The Comprehensive Impact of Offshore IT Software and Services Outsourcing on the U.S. Economy and the IT Industry." Lexington, MA: Global Insight (USA), Inc., 2004.

_____. "The Estimated Impact of Offshore IT Software and Services Outsourcing on each State Economy, 2003 and 2008." Lexington, MA: Global Insight (USA), Inc., March 2004.

Global Insight and Information Technology Association of America. "The Comprehensive Economic Impact of Offshore IT Software and Services Outsourcing in the United States." Presentation at the National Press Club, Washington, D.C., 30 March 2004.

"Globalisation: Coping with the Challenge." Editorial, *OECD Employment Outlook*. OECD, 2005.

Goodman, William C. "Employment in Services Industries Affected by Recessions and Expansions." *Monthly Labor Review* (October 2001): 3-11.

Goolsby, Kathleen, Todd Furniss, and F. Keaton Whitlow. "An Assessment of the Outsourcing Market in the Banking Sector of Japan's Financial Institutions Industry." Dallas: Everest Group, 2002.

Gorg, Holger, Aoife Hanley, and Eric Strobl. "Productivity effects of international outsourcing: Evidence from plant level data." University of Nottingham, Ecole Polytechnique Paris: October 2005. Presented at the OECD Conference. Paris, France, November 2005.

Gressner, Edward, Paul Weinstein, Jr., and Will Marshall. *Raising Our Game—A National Competition Strategy*. Washington, D.C.: Progressive Policy Institute, June 2006.

Grieco, Elizabeth M. "Temporary Admissions of Non-immigrants to the United States: 2005." DHS Office of Immigration Statistics, July 2006.

_____. "Estimates of the Non immigrant Population in the United States: 2004." DHS Office of Immigration Statistics, June 2006.

Griswold, Daniel T. "Why We Have Nothing to Fear from Foreign Outsourcing." Center for Trade Policy Studies, Cato Institute, *Free Trade Bulletin* 10 (March 2004).

Groshen, Erica L. and Simon Potter. "Has Structural Change Contributed to a Jobless Recovery?" Federal Reserve Bank of New York, *Current Issues in Economics and Finance* 9 (8) (August 2003).

Grossman, Gene. "Offshoring and Outsourcing: Lessons from the Theory of the Firm." Presentation, undated.

Grossman, Gene M. and Elhanan Helpman. "Outsourcing in a Global Economy." September 2001.

Hagel, John, III. "Offshoring Goes on the Offensive." *The McKinsey Quarterly* 2 (2004).

Hanson, Gordon H., Raymond J. Mataloni, Jr., and Matthew J. Slaughter. "Expansion Abroad and the Domestic Operations of U.S. Multinational Firms." Working paper. Washington, D.C.: National Bureau of Economic Research, September 2003.

Hanson, Gordon H. and Chong Xiang. "International Trade in Motion Picture Services." University of California, San Diego, National Bureau of Economic Research, and Purdue University. Presented at the Conference on International Service Flows. Bethesda, ...MD, April 2006.

Harrington, Paul E. "Understanding & Responding to Imbalances in Engineering & IT Labor Markets." Presentation to Business Roundtable, Northeastern University, 15 September 2004.

Harrison, Ann and Margaret McMillan. "Outsourcing Jobs? Multinationals and US Employment." NBER Working Paper #12373. Washington, D.C.: National Bureau of Economic Research, July 2006.

Hatzichronoglou, Thomas. "The Impact of Offshoring on Employment: Measurement Issues and Implications." Presented at the OECD Conference. Paris, France, November 2005.

Hassett, Kevin A. "Discussion of Desai, Foley and Hines." AEI Conference on *Domestic Effects of Foreign Direct Investment*, 2 December 2004.

Hecker, Daniel E. "Occupational Employment Projections to 2012." *Monthly Labor Review* (February 2004).

Helpman, Elhanan, Marc J. Melitz, and Stephen R. Yeaple. "Export versus FDI." Discussion paper #1998. Cambridge, MA: Harvard Institute of Economic Research, 2003.

Hijzen, Alexander, Holger Görg and Robert C. Hine. "International Outsourcing and the Skill Structure of Labour, Demand in the United Kingdom." University of Nottinham, 2004. Presented at the OECD Conference. Paris, France, November 2005.

Hira, Ronil. "Global Outsourcing of Engineering Jobs: Recent Trends and Possible Implications." Testimony to the Committee on Small Business, U.S. House of Representatives, 18 June 2003.

_____. "Homeland Security and the Technology Sector." Testimony to the Senate Commerce, Science, and Transportation Subcommittee on Science, Technology and Space, 24 April 2002.

_____. "The Offshoring of High-Skilled Jobs." Testimony to the Committee on Small Business, U.S. House of Representatives, 20 October 2003.

_____. "The Other Side of the Outsourcing Debate." Transcript, Washingtonpost.com Live Discussion. 2 May 2005 <http://www.washingtonpost.com/wp-dyn/articles/A36379-2004Mar30.html>.

_____. Letter to Congressman Frank Wolf, April 21, 2004.

Hira, Ron and Anil Hira. "Outsourcing America." New York: American Manufacturing Association, 2005.

Hong, Eun-Pyo. "OECD Activity on the Short-Term Indicators for Services." Presented at 18th Voorburg Group Meeting, Tokyo, October 2003.

Horrigan, Michael W. "Employment Projections to 2012: Concepts and Context." *Monthly Labor Review* (February 2004).

Houghton, John W. and Graham Vickery. "Digital Delivery of Business Services." Paris: Organisation for Economic Co-operation and Development, 2004.

Houseman, Susan. "Outsourcing, Off-shoring and Productivity Measurement in Manufacturing." Draft Working Paper. Upjohn Institute for Employment Research, June 2006.

Hubbard, Glenn. "Does the Tax System Create Excessive Incentives to Move Activity Abroad?" Remarks at International Tax Policy Forum, AEI Conference on *Domestic Effects of Foreign Direct Investment*, 2 December 2004.

Hughes, Kent H. "Introduction: Meeting the New Economic Challenge: Forging an American Dream for the Twenty-First Century." *Building the Next American Century*. Baltimore, MD: The Johns Hopkins University Press, February 2005.

Information Technology Association of America. "ITAA Global Sourcing Principles." Arlington, VA: ITAA, August 2003.

____. "Race to the Horizon: Competition, Innovation and Enlightened Public Policy Must Drive the U.S. IT Industry in the Next Four Years." Arlington, VA: ITAA, January 2005.

The Institute of Electrical and Electronics Engineers. "Summary report: IEEE-USA Salary & Fringe Benefit Survey, 2004 Edition." New York: 2004.

_____. "2004 IEEE-USA Unemployment survey Results (11/29/2004)." New York: 2004.

_____. "Position: Offshore Outsourcing—As approved by the IEEE-USA Board of Directors, March 2004." The Institute of Electrical and Electronics Engineers, Inc., 2004.

Institute for International Education. "Open Doors 2006." New York: IIE, 2006.

Interindustry Economic Research Forum (Inforum). "The Trade and Economic Impacts of U.S. Currency Valuation: A Global Modeling Analysis." Submitted to the Department of Commerce International Trade Administration. January 2005.

International Association for the Evaluation of Educational Achievement. "Trends in International Mathematics and Science Study (TIMSS) 2003."

Irwin, Douglas A. "'Outsourcing' is Good for America." Washington, D.C.: American Enterprise Institute for Public Policy Research, February 2004.

_____. "U.S. Direct Investment Abroad: A Historical Perspective." Presented at AEI Conference on *Domestic Effects of Foreign Direct Investment*, 2 December 2004.

Jaffee, Dwight. "Globalization, Offshoring, and Economic Convergence: A Synthesis." Presented at the *Understanding Global Outsourcing Conference*, Stern School of Business, 10 December 2004.

Jain, Kuldeep P., Nigel A. S. Manson, and Shirish Sankhe. "The Right Passage to India." *The McKinsey Quarterly* (February 2005).

Jensen, J. Bradford and Lori G. Kletzer. "Tradable Services: Understanding the Scope and Impact of Services Offshoring." Presentation, undated.

_____. "Tradable Services: Understanding the Scope and Impact of Services Offshoring." Paper prepared for Brookings Trade Forum 2005 *Offshoring White-Collar Work – The Issues and the Implications*, 12-13 May 2005.

"Jobs Lost to Outsourcing Underestimated, Study Concludes." *The Business Journal* (20 October 2004).

Kalakota, Ravi and Marcia Robinson. "Five Reasons Why Offshore Outsourcing Projects Fail." *Sterling Hoffman Executive Search Newsletter* (undated). 2 May 2005 <http://www.sterlinghoffman.com/cgi-bin/index.pl?p=newsletter/articles/article112.html>.

Kapur, Devesh, and John McHale. "Give Us Your Best and Brightest: The Global Hunt for Talent and its Impact on the Developing World." Baltimore: Brookings Institution Press, 2005.

Karamouzis, Frances, et al. "Gartner's Global Offshore Sourcing Predictions." COM-22-9634. Stamford, CT: Gartner Inc., 2004.

Karoly, Lynn A. and Constantijn W. A. Panis. "The 21st Century at Work—Forces Shaping the Future Workforce and Workplace in the United States." RAND, Report for the U.S. Department of Labor, 2004.

Kazmierczak, Matthew F. and Josh James. "Losing the Competitive Advantage? The Challenge for Science and Technology in the United States." Washington, D.C.: American Electronics Association, February 2005.

Khatchadourian, Kelley, and Alice Wiesner. "International Price Program's (IPP's) .....Services Price Indexes." Washington, D.C.: U.S. Bureau of Labor Statistics. Presented at the Conference on International Service Flows. Bethesda, MD, April 2006.

Kirkegaard, Jacob Funk. "Outsourcing and Offshoring: Pushing the European Model Over the Hill, Rather Than Off the Cliff!" WP 05-1. Washington, D.C.: Institute for International Economics, March 2005.

_____. "Outsourcing—Stains on the White Collar?" Washington, D.C.: Institute for International Economics, 2003.

Kleinert, Jörn. "Globalization: Empirical Overview and Theoretical Explanations." In *The Role of Multinational Enterprises in Globalization.* New York: Springer, 2004.

Kletzer, Lori G. *Job Loss from Imports: Measuring the Costs*. Washington, D.C.: Institute for International Economics, 2001.

_____. "Measuring the Costs of Trade-Related Job Loss." Testimony prepared for the Committee on Finance, U.S. Senate, 20 July 2001.

Koch, Christopher. "Backlash." *CIO Magazine* (September 1, 2003).

Kozlow, Ralph H. "An Overview of U.S. Bureau of Economic Analysis Statistics on Multinational Companies." Prepared for the OECD Workshop on *International Investment Statistics*, Paris, France, 22-24 March 2004.

Kozlow, Ralph H. and Maria Borga. "'Offshoring' and the U.S. Balance of Payments." U.S. Bureau of Economic Analysis WP2004-05 (16 July 2004). Presented at the Brookings Institution, 22 June 2004.

Krantz, Rachel. "Employment in business services: a year of unprecedented decline." *Monthly Labor Review* (April 2002): 17-24.

Kroll, Cynthia A. "At-Risk Occupations." September 2004.

_____. "State and Metropolitan Area Impacts of the Offshore Outsourcing of Business Services and I.T." Fisher Center for Real Estate and Urban Economics, Working Paper 05-293. Berkley: University of California, 2003. NOT FOR QUOTATION WITHOUT PERMISSION.

Landefeld, J. Steven and Ralph Kozlow. "Globalization and Multinational Companies: What are the Questions, and How Well are we Doing in Answering them?" Presented at the Conference of European Statisticians, Globalization Seminar, Geneva, 10-12 June 2003.

Landefeld, J. Steven and Raymond Mataloni. "Offshore Outsourcing and Multinational Companies." U.S. Bureau of Economic Analysis WP2004-06 (16 July 2004). Presented at the Brookings Institution, 22 June 2004.

Leamer, Edward E. "Effort, Wages, and the International Division of Labor." Working Paper 5803. Cambridge, MA: National Bureau of Economic Research, October 1996.

_____. "Trade, Wages and Revolving Door Ideas." Working Paper 4716. Cambridge, MA: National Bureau of Economic Research, April 1994.

Leamer, Edward E. and James Levinsohn. "International Trade Theory: The Evidence." Working Paper 4940. Cambridge, MA: National Bureau of Economic Research, November 1994.

Leamer, Edward E. and Michael Storper. "The Economic Geography of the Internet Age." Working Paper 8450. Cambridge, MA: National Bureau of Economic Research, August 2001.

Levine, Linda. "Offshoring (a.k.a. Offshore Outsourcing) and Job Insecurity Among U.S. Workers." CRS Report to Congress (RL32292). Washington, D.C.: Congressional Research Services, 18 June 2004.

Levy, Frank and Ari Goelman. "Offshoring and Radiology." Presented at Brookings Trade Forum 2005 *Offshoring White-Collar Work – The Issues and the Implications*, 12-13 May 2005.

Lieberman, Joseph I. Letter to Donald Evans and Elaine Chao. 13 December 2004.

_____. Dear Colleague letter. 15 December 2005.

_____. "Data Dearth in Offshore Outsourcing: Policymaking Requires Facts." December 2004.

_____. "Offshore Outsourcing and America's Competitive Edge: Losing Out in the High Technology R&D and Services Sectors." 11 May 2004.

Lindsey, Brink. "Job Losses and Trade: A Reality Check." Trade Briefing Paper No. 19. Washington, D.C.: Cato Institute, March 2004.

Lipsey, Robert E. "Foreign Production by US Firms and Parent Firm Employment." In *Multinational Firms and Impacts on Employment, Trade and Technology.* London: Routledge, 2002.

_____. "Measuring International Trade in Services." Presented at the Conference on International Service Flows. Bethesda, MD, April 2006.

Lipsey, Robert E. and Jean-Louis Mucchielli. "Introduction." In *Multinational Firms and Impacts on Employment, Trade and Technology.* London: Routledge, 2002.

Lloyd, Emily and Charlotte Mueller. "Payroll employment grows in 2004." *Monthly Labor Review* (March 2005): 18-31.

Lopez-Bassols, Vladimir. "ICT Skills and Employment." Paris: OECD, 2002.

Lowell, Lindsay B. "The Best and the Brightest: Immigrant Professionals in the United States at the end of the 1990s." Institute for the Study of International Migration, 2005.

Makin, John H. "America Demands; China Supplies." *American Enterprise Institute Online* (19 March 2004). 28 April 2005 <http://www.aei.org/publications/pubID.20142,filter.all/pub_detail.asp>.

Mankiw, N. Gregory, Kristin J. Forbes, and Harvey S. Rosen. "The Economic Report of the President." Testimony before the Joint Economic Committee, U.S. Congress, 10 February 2004.

Mankiw, N. Gregory and Phillip Swagel. "The Politics and Economics of Off-shore Outsourcing." AEI Working paper # 122. American Enterprise Institute, December 2005.

Mann, Catherine L. "Global Sourcing: The Information Technology Example." Presented 7 February 2005 at the Cosmos Club, Washington, D.C.

_____. "Global Sourcing & High Tech Jobs: Productivity Gains & Policy Challenges." Presented 11 March 2004.

_____. "Globalization of IT Services and White Collar Jobs: The Next Wave of Productivity Growth." *International Economics Policy Briefs* PB03-11. Washington, D.C.: Institute for International Economics, December 2003.

_____. "Globalization of Services: Why, How Much, and What to do About it: Some Issues for the North and for the South." February 2004.

_____. "Offshore Outsourcing and the Globalization of US Services: Why Now, How Important, and What Policy Implications." In *The United States and the World Economy: Foreign Economic Policy for the Next Decade*. Washington, D.C.: Institute for International Economics, 2005.

_____. "Prices for International Services Transactions." Washington, D.C.: U.S. Bureau of Labor Statistics, September 2004.

_____. "This is Bangalore Calling: Hang Up or Speed Dial?" Cleveland: Federal Reserve Bank of Cleveland, January 2005.

Mann, Catherine L. and Jacob F. Kirkegaard. *Accelerating the Globalization of America*. Washington, D.C.: Institute for International Economics, 2006.

Manpower Professional. "Talent Shortage and Wage Inflation Survey: Global Results." October 2006.

Mariotti, Sergio and Lucia Piscitello. "Foreign Direct Investment and Employment: Home country experience in Italy." In *Multinational Firms and Impacts on Employment, Trade and Technology.* London: Routledge, 2002.

Markusen, James R. "Modeling the Offshoring of White-Collar Services: From Comparative Advantage to the New Theories of Trade and FDI." Prepared for the Brookings Forum, *Offshoring White-Collar Work: The Issues and Implications*, 12-13 May 2005.

Mataloni, Raymond J., Jr. "U.S. Multinational Companies: Operations in 2002." *Survey of Current Business* (July 2004): 10-29.

Mattoo, Aaditya and Sacha Wunsch. "Preempting Protectionism in Services: The GATS and Outsourcing." January 2004.

McCarthy, John C. "Near-Term Growth of Offshoring Accelerating." Cambridge, MA: Forrester Research, Inc., 2004.

McKinsey Global Institute. *The Emerging Global Labor Market.* San Francisco: McKinsey and Company, 2005.

_____. "Offshoring: Is it a Win-Win Game?" San Francisco, CA: McKinsey and Company, August 2003.

"The McKinsey Global Survey of Business Executives, July 2004." *The McKinsey Quarterly Special Edition: What global executives think* (2004).

McNeil, Lawrence R. "International Trade and Economic Growth: A Methodology for Estimating Cross-Border R&D Spillovers." Washington, D.C.: U.S. Bureau of Economic Analysis. Presented at the Conference on International Service Flows. Bethesda, MD, April 2006.

Meeks, Ronald L. "Federal Funds for R&D and R&D Plant Projected at $110 Billion for FY 2005." *SRS InfoBrief* (NSF 06-300). Arlington, VA: National Science Foundation, November 2005.

Mehlman, Bruce P. "Offshore Outsourcing and the Future of American Competitiveness." Washington, D.C.: U.S. Department of Commerce, October 2003.

Meltzer, Allan H. "A Jobless Recovery?" Washington, D.C.: American Enterprise Institute for Public Policy Research, November 2003.

Miano, John. "The Bottom of the Pay Scale: Wages for H-1B Computer Programmers." Washington, DC: Center for Immigration Studies, December 2005.

Miller, Ronald E., and Peter D. Blair. *Input-Output Analysis: Foundations and Extensions.* Englewood Cliffs, New Jersey: Prentice Hall Inc., 1985.

Morisi, Teresa L. "Recent changes in the national Current Employment Statistics survey." *Monthly Labor Review* (June 2003).

Moris, Francisco. "U.S. International Trade in R&D-related Services and Transactions-based Profile of Business R&D." Arlington, VA.: National Science Foundation. Presented at the Conference on International Service Flows. Bethesda, MD, April 2006.

Morissette, René and Anick Johnson. "Are Good Jobs Disappearing in Canada?" Analytical Studies Branch research paper series, no. 239. Ottawa: Statistics Canada, January 2005.

Moyer, Brian C., Mark A. Planting, Paul V. Kern, and Abigail M. Kish. "Improved Annual Industry Accounts for 1998-2003: Integrated Annual Input-Output Accounts and Gross-Domestic-Product-by-Industry Accounts." *Survey of Current Business* (June 2004): 21-57.

Mutti, John, and Harry Grubert. "New Developments in the Effect of Taxes on Royalties and the Migration of Intangible Assets Abroad." Presented at the Conference on International Service Flows. Bethesda, MD, April 2006.

National Academies. *Policy Implications of International Graduate Students and Postdoctoral Scholars in the United States*. Washington, D.C.: National Academies Press, 2005.

National Academy of Public Administration. Concept Paper for Offshoring Study. December 2004.

_____. Final Offshoring Proposal. January 2005.

_____. *Off-shoring: An Elusive Phenomenon*. Washington, D.C.: January 2006.

_____. *Off-shoring: How Big Is It?* Washington, D.C.: October 2006.

National Association of Manufacturers. *The Looming Workforce Crisis: Preparing American Workers for 21st Century Competition*. Washington, DC: National Association of Manufacturers, 2005.

National Bureau of Economic Research. "Business Cycle Expansions and Contractions." 2 May 2005 <http://www.nber.org/cycles.html>.

National Bureau of Statistics of China. "Progress Report from National Bureau of Statistics of China." Presented at Voorburg 18th Meeting, 18 October 2003.

National Research Council, Committee on Analyzing the U.S. Content of Imports and the Foreign Content of Exports. "Analyzing the U.S. Content of Imports and the Foreign Content of Exports." Washington, D.C.: National Academies Press, October 2005.

National Research Council, Committee on National Statistics. "Principles and Practices for a Federal Statistical Agency." Third Edition. Washington, D.C.: National Academies Press, 2004-2005.

National Science Board. *Science and Engineering Indicators 2006, Volume 1* (NSB 06-01). Arlington, VA: National Science Foundation, 2006.

_____. *Science and Engineering Indicators 2006, Volume 2* (NSB 06-01A). Arlington, VA: National Science Foundation, 2006.

National Science Foundation. "Next Generation Cybertools." NSF Funding Opportunity Document, May 2005.

_____. Summary of SBE/CISE Workshop on "Cyberinfrastructure for the Social and Behavioral Sciences." 15-16 March 2005.

_____. "Survey of Earned Graduates." Arlington, VA: 2005.

"Nations Anxious to See if They Make the Grade," *Financial Times*, October 18, 2006.

neoIT. "Research Summary: Global ITO and BPO Trends in 2005." *Offshore Insights Market Report Series* 2 (12) (December 2004).

_____. "Research Summary: Offshore and Nearshore ITO Salary Report 2004." *Offshore Insights Market Report Series* 3 (5) (May 2005).

_____. "Research Summary: Mapping Offshore Markets Update 2004." *Offshore Insights White Paper* 2 (6) (June 2004).

Neuschatz, Michael and Patrick J. Mulvey. "Physics Students from Abroad: Monitoring the Continuing Impact of Visa Problems." College Park, MD: American Institute of Physics, #R-440, September 2005.

Norwood, Janet L. "The Changing World of Employment: Factory Jobs, Productivity, and Worker Quality." Washington, D.C.: Committee on National Statistics, October 2004.

"A Note on Patterns of Production and Employment by U.S. Multinational Companies." *Survey of Current Business* (March 2004).

Novak, Christopher A. and Matthew F. Kazmierczak. "Offshore Outsourcing in an Increasingly Competitive and Rapidly Changing World: A High-Tech Perspective." Washington, D.C.: American Electronics Association, March 2004.

Nyce, Steven A., and Sylvester J. Schieber. "The Economic Implications of Aging Societies: The Costs of Living Happily Ever After." New York: Cambridge University Press, 2005.

Office of Inspector General. *Review of Vulnerabilities and Potential Abuses of the L-1 Visa Program* (draft). Washington, D.C.: Department of Homeland Security, 2006.

_____. *Approval of H-1B Petitions Exceeded Cap in FY2005* (#OIG-05-49). Washington, D.C.: Department of Homeland Security, September 2005.

Okolie, Cordelia. "Why size class methodology matters in analyses of net and gross job flows." *Monthly Labor Review* (July 2004).

O'Neill, Vin. "IEEE-USA Perspectives on the Adequacy of Available Data on Off-Shore Outsourcing." Presented at National Academy of Public Administration, Washington, D.C., May 2005.

Organisation for Economic Co-operation and Development. "Chapter 2: Globalisation of the ICT Sector: Section on International Sourcing." In *Information Technology Outlook 2004*. Paris: OECD, 2004.

_____. *Education at a Glance: OECD Indicators 2005*. Paris: OECD, 2005.

_____. *Main Science and Technology Indicators*. Paris: OECD, 2004.

_____. *Measuring Globalization: OECD Handbook on Economic Globalization Indicators*. Paris: OECD, 2005.

_____. "OECD Workshop on Services." Conference Materials. Paris, 15-16 November 2004.

_____. "Trade-adjustment Costs in OECD Labour Markets: Three Annexes." Annexes to Chapter 1 of the *OECD Employment Outlook 2005*. Paris: OECD, 2005.

Organisation for Economic Co-operation and Development, Economics Department. "The Benefits of Liberalising Product Markets and Reducing Barriers to International Trade and Investment: The Case of the United States and the European Union." Working Paper no. 432. Paris: OECD, May 2005.

Organisation for Economic Co-operation and Development, Trade Union Advisory Committee. "Trade, Offshoring of Jobs and Structural Adjustment: The Need for a Policy Response." TUAC discussion paper. Paris: OECD, 2004.

Orlov, Laurie M. and John C. McCarthy. "IT Is Not Going Away—But The Worker Profile Changes: More Business-Centric White-Collar Roles Replacing Blue-Collar Technical Jobs." Cambridge, MA: Forrester Research, Inc., 2005.

Pain, Nigel and Desirée van Welsum. "International Production Relocation and Exports of Services." Paris: OECD, 2004.

Palan, Ronen. "The Offshore World: Sovereign Markets, Virtual Places, and Nomad Millionares." Ithica and London: Cornell University Press, 2003.

"Panel session on ICT-enabled services offshoring: country and business perspectives." Summary, meeting of the OECD Working Party on the Information Economy, June 2005.

Parker, Andrew. "Two-Speed Europe: Why 1 Million Jobs Will Move Offshore." Cambridge, MA: Forrester Research, Inc., 2004.

Pilat, Dirk. "The Globalisation of Production and Value Chains: Issues for Discussion." Presented at the OECD Conference. Paris, France, ... November 2005.

Pinkston, Joshua C. and James R. Spletzer. "Annual Measures of Job Creation and Job Destruction Created from Quarterly ES-202 Microdata." Washington, D.C.: U.S. Bureau of Labor Statistics, undated.

Pivetz, Timothy R., Michael Searson, and James R. Spletzer. "Measuring job and establishment flows with BLS longitudinal microdata." *Monthly Labor Review* (April 2001):13-20.

Population Projections Program, U.S. Census Bureau. "Projections of the Resident Population by Age, Sex, Race, and Hispanic Origin: 1999 to 2100." Washington, DC: 2000.

President's Council of Advisors on Science and Technology. *Sustaining the Nation's Innovation Ecosystems: Report on Information Technology Manufacturing and Competitiveness*. Washington, D.C.: January 2004.

President's Council of Advisors on Science and Technology. *Sustaining the Nation's Innovation Ecosystem: Report on Maintaining the Strength of Our Science & Engineering Capabilities.* Washington, D.C.: June 2004.

Pricewaterhouse Coopers. "Management Barometer Survey on Outsourcing of Financial Functions: US Findings." Pricewaterhouse Coopers, 2004.

"Progress Report – Bureau of the Census/Bureau of Labor Statistics." Presented at Voorburg Group, 18th Meeting, Tokyo, Japan, October 2003.

Quinn, James Brian and Frederick G. Hilmer. "Strategic Outsourcing." *The McKinsey Quarterly* 1 (1995).

Rabaud, Isabelle. "Sixth OECD-Eurostat Meeting of Experts in Trade-in-Services Statistics (TIS)." OECD, Paris La Défense, 14th September, 2005. Presented at the OECD Conference. Paris, France, November 2005.

Randolph, William. Comments on Slaughter presentation "Expansion Abroad and the Domestic Operations of U.S. Multinational Firms." AEI Conference on *Domestic Effects of Foreign Direct Investment*, 2 December 2004.

Research and Policy Committee of the Committee for Economic Development. *Reforming Immigration: Helping Meet America's Need for a Skilled Workforce: A Statement on National Policy*. New York: Committee for Economic Development, 2001.

Regets, Mark C. "What Do People Do After Earning an S&E Bachelor's Degree?" *SRS InfoBrief* (NSF 06-324). Arlington, VA: National Science Foundation, July 2006.

République Française, Département des Activités tertiaires [French Republic, Department of the Tertiary Sector]. 2003 Progress Report for France. Presented at 18th Voorburg Group Meeting on Service Statistics. Paris: 9 September 2003.

Robbins, Carol A. "Measuring Payments for the Supply and Use of Intellectual Property." Presented at the Conference on International Service Flows. Bethesda, MD, April 2006.

Robinson, Marcia. Interview with *Journal of Business Strategy*. November 2004.

Robinson, Marcia, and Ravi Kalakota. "Offshore Outsourcing: Business Models, ROI and Best Practices." Alpharetta, GA: Mivar Press, 2004.

Rosenthal, Beth Ellyn. "Deloitte Study Discovers 75 Percent of Global Financial Institutions Plan to Outsource Offshore." June 2003.

Samuelson, Paul A. "Where Ricardo and Mill Rebut and Confirm Arguments of Mainstream Economists Supporting Globalization." *The Journal of Economic Perspectives* 18 (3) (Summer 2004): 135-146.

Saunders, Norman C. "Coding Occupations for Risk of Offshore Outsourcing." Washington, D.C.: Bureau of Labor Statistics, undated.

Sayeed, Asad and Radhika Balakrishnan. "Why do Firms Disintegrate? Towards an Understanding of the Firm-level Decision to Subcontract and its Implications for Labor." In *Labor and the Globalization of Production: Causes and Consequences of Industrial Upgrading.* New York: Palgrave Macmillan, 2005.

Schultze, Charles L. "Offshoring, Import Competition, and the Jobless Recovery." *The Brookings Institution Policy Brief #136* (August 2004).

Sengupta, Somini. "Skills Gap Threatens Technology Boom in India." *The New York Times* 10/17/06.

Sicsic, Pierre. "Are there more and more missing imports of services in the French Balance of Payments?" Balance of Payments, Banque de France. Presented at the Conference on International Service Flows. Bethesda, MD, April 2006.

Scott, Robert E. "The High-Price of 'Free' Trade: NAFTA's failure has cost the United States jobs across the nation." Economic Policy Institute briefing paper. Washington, D.C.: EPI, November 2003.

_____. "U.S.-China Trade, 1989-2003: Impact on Jobs and Industries, National and State-by-State." Economic Policy Institute Working Paper #270. Washington, D.C.: EPI, January 2005.

"Services Offshoring: What do the Data Tell Us?" Workshop hosted by the Brookings Institution, 22 June 2004.

Shackelford, Brandon. "U.S. R&D Continues to Rebound in 2004." *SRS InfoBrief* (NSF 06-306). Arlington, VA: National Science Foundation, January 2006.

Shared Services News 6 (10) (February 2005).

Slaughter, Matthew J. "Does the Tax System Create Excessive Incentives To Move Economic Activity Abroad?" ITPF/AEI Seminar on *Domestic Effects of Foreign Direct Investment*, Washington, D.C., 2 December 2004.

_____. "Expansion Abroad and the Domestic Operations of U.S. Multinational Firms." ITPF/AEI Seminar on *Domestic Effects of Foreign Direct Investment*, Washington, D.C., 2 December 2004.

_____. "Globalization and Employment by U.S. Multinationals: A Framework and Facts." March 2004.

Solomon, Jay. "Offshoring of Jobs to Widen in 2005: Study Says Growth Helped By Less Political Opposition, More Pressure to Cut Costs." *The Wall Street Journal Online* (2004).

Spletzer, James R., et al. "Business employment dynamics: new data on gross job gains and losses." *Monthly Labor Review* (April 2004): 29-42.

Srinivasan, T.N. "Information Technology Enabled Services and India's Growth Prospects." Presented at the Brookings Forum, *Offshoring White-Collar Work: The Issues and Implications*, May 12-13, 2005.

Statistics Canada. *Occupation: 2001 Census Technical Report*. Cat. No. 92-388-XIE.

Statistics Sweden. "Progress Report of Sweden." Presented at 18th Meeting of the Voorburg Group, Tokyo, Japan, October 2003.

Sturgeon, Timothy J., Frank Levy, Clair Brown, J. Bradford Jensen, and David Weil. "Services Off-shoring Working Group Final Report." Cambridge: Industrial Performance Center, MIT, September 2006.

Swaim, Paul. "Trade-adjustment Costs in OECD Labour Markets: A Mountain or a Molehill?" ISBN 92-64-01045-9, OECD Employment Outlook. Presented at the OECD Conference. Paris, France, November 2005.

Tanaka, Nobuo. "Main Messages from the OECD Services Project and its Background." Presented 20 April 2005.

Title V—Confidential Information Protection and Statistical Efficiency. Pub. L. 107–347, 17 Dec. 2002, 116 Stat 2962.

Trefler, Daniel. "Offshoring: Threats and Opportunities." Prepared for the Brookings Forum, *Offshoring White-Collar Work: The Issues and Implications*, 12-13 May 2005.

Triplett, Jack, and Barry P. Bosworth. "Productivity in the U.S. Services Sector: New Sources of Economic Growth." Washington, D.C.: The Brookings Institution Press, 2004.

Triplett, Jack E. and Barry P. Bosworth. "Productivity Measurement Issues in Service Industries: 'Baumol's Disease' Has Been Cured." *FRB NY Economic Policy Review* (September 2003): 23-33.

United Nations, et al. "Manual on Statistics of International Trade in Services." Geneva: United Nations, 2002.

U.S. Bureau of Economic Analysis. U.S. Bureau of Economic Analysis Strategic Plan for FY 2005-FY 2009.

_____. U.S. Direct Investment Abroad: Country and Industry Detail for Capital Outflows, 2000." <http://www.bea.gov/bea/di/usdiacap.htm#2000>

_____. "Foreign Direct Investment in the U.S.: Country and Industry Detail for Capital Inflows, 2001." <http://www.bea.gov/bea/di/fdi21web.htm#2001>

U.S. Bureau of Labor Statistics. "Cooperating State Agencies: Occupational Employment and Statistics (OES) Program."

U.S. Bureau of Labor Statistics and U.S. Census Bureau. "Current Population Survey: Design and Methodology." Technical Paper 63RV. Washington, D.C.: March 2002.

U.S. Census Bureau, Bureau of Economic Analysis and National Science Foundation, Division of Science Resources Statistics. "Research and Data Development Link Project Final Report." Washington, D.C.: June 2005.

U.S. Chamber of Commerce. "Jobs, Trade, Sourcing, and the Future of the American Workforce." Washington, D.C.: U.S. Chamber of Commerce, April 2004.

U.S. China Economic and Security Review Commission. "2004 Report to Congress." 108th Congress, 2nd Session. Washington, D.C.: June 2004.

U.S. Department of Commerce. "Manufacturing in America: A Comprehensive Strategy to Address the Challenges to US Manufacturers." Washington, D.C.: U.S. Department of Commerce, January 2004.

U.S. Department of Labor. "Business Employment Dynamics: Second Quarter 2004." *Bureau of Labor Statistics News* (15 February 2005) USDL 05-207.

_____. "Employment Situation: May 2005." *Bureau of Labor Statistics News* (3 June 2005) USDL 05-965.

_____. "Extended Mass Layoffs Associated With Domestic and Overseas Relocations, First Quarter 2004." *Bureau of Labor Statistics News* (10 June 2004) USDL 04-1038.

_____. "Extended Mass Layoffs in 2003." Report 982. Washington, D.C.: December 2004.

_____. "Extended Mass Layoffs in the Fourth Quarter of 2004 and Annual Averages for 2004." *Bureau of Labor Statistics News* (16 February 2005) USDL 05-264.

_____. "Job Openings and Labor Turnover: February 2005." *Bureau of Labor Statistics News* (12 April 2005) USDL 05-622.

_____. "Mass Layoffs in February 2005." *Bureau of Labor Statistics News* (24 March 2005) USDL 05-486.

_____. "Occupational Employment and Wages, November 2003." *Bureau of Labor Statistics News* (12 November 2004) USDL 04-2320.

_____. "Occupational Employment and Wages, May 2003." Bulletin 2567. Washington, D.C.: Bureau of Labor Statistics, September 2004.

_____. "Worker Displacement, 2001-03." *Bureau of Labor Statistics News* (30 July 2004) USDL 04-1381.

U.S. Government Accountability Office. "International Trade: Current Government Data Provide Limited Insight into Offshoring of Services." Report to Congressional Requesters GAO-04-932. Washington, D.C.: GAO, September 2004.

_____. "H-1B Foreign Workers: Better Tracking Needed to Help Determine H-1B Program's Effects on U.S. Workforce" (GAO 03-883). Washington, D.C.: GAO, September 2003.

_____. "International Trade: U.S. and India Data on Offshoring Show Significant Differences" (GAO-06-116). Presented at the OECD Conference. Paris, France, November 2005.

U.S. International Trade Commission. "Examination of U.S. Inbound and Outbound Direct Investment." Publication 3383. Washington, D.C.: U.S. International Trade Commission, January 2001.

_____. "Industry Trade and Technology Review." Publication 3253. Washington, D.C.: U.S. International Trade Commission, October 1999.

_____. "Industry Trade and Technology Review." Publication 3661. Washington, D.C.: U.S. International Trade Commission, November 2003.

_____. "Recent Trends in U.S. Services Trade: 2004 Annual Report." Publication 3703. Washington, D.C.: International Trade Commission, June 2004.

"Value and Performance." The McKinsey Quarterly. Special Edition. New York: McKinsey and Company, 2005.

Van Welsum, Desirée. "In Search of 'Off Shoring': Evidence from U.S. Imports of Services." London: Birkbeck University of London, 2004.

_____. "International services sourcing: Opportunities and challenges." Presented at European e-Skills Conference 2004, Thessalonica, Greece, 20-21 September 2004.

Van Welsum, Desirée and Xavier Reif. "Potential Offshoring: Evidence from Selected OECD Countries." Presented at the Brookings Forum, *Offshoring White-Collar Work: The Issues and Implications*, 12-13 May 2005.

_____. "We can work it out – The globalisation of ICT-enabled services." Presented at the Conference on International Service Flows. Bethesda, MD, April 2006.

Van Welsum, Desirée and Graham Vickery. "Potential Offshoring of ICT-Intensive Using Occupations." Paris: Organisation for Economic Co-operation and Development, 2005. Presented at the OECD Conference. Paris, France, November 2005.

Vargo, Franklin J. "NAFTA: A Ten Year Perspective and Implications for the Future." Testimony before the Subcommittee on International Economic Policy, Export, and Trade Promotion, 20 April 2004.

Vashistha, Atul, and Avinash Vashistha. "The Offshore Nation: The Rise of Services Globalization." New Delhi: Tata McGraw-Hill Publishing Company, 2005.

Venkatraman, N. Venkat. "Offshoring Without Guilt." *MIT Sloan Management Review* 45 (3) (Spring 2004): 14-16.

Ventoro. "Offshore 2005 Research: Preliminary Findings and Conclusions." Hillsboro, OR: Ventoro, October 2004.

"Voorburg 2003: Progress Report from the UK." Presented at 18th Meeting of the Voorburg Group, Tokyo, Japan, October 2003.

Wasem, Ruth Ellen. *Immigration: Legislative Issues on Nonimmigrant Professional Specialty (H-1B) Workers* (RL30498). Washington, D.C.: Congressional Research Service, February 12, 2004.

Wessel, David. "In Spite of Offshoring, U.S. Students Can Still Engineer a Career." *The Wall Street Journal Online* (16 June 2005).

Whichard, Obie G. "Measuring Globalization: The Experience of the United States of America." Prepared for the 22nd CEIES Seminar, *Statistics and Economic Globalisation*, Copenhagen, Denmark, 2-3 June 2003.

_____. "Multiple Indicators for Multiple Uses: United States Statistics on Foreign Direct Investment." Presented at OECD World Forum on Key Indicators, Palermo, 10-13 November 2004.

Wölfl, Anita. "The Service Economy in OECD Countries." Science, Technology and Industry Working Paper 2005/3. Paris: OECD, 2005.

World Intellectual Property Organization. *WIPO Patent Report: Statistics on Worldwide Patent Activities.* Geneva: World Intellectual Property Organization, 2006.

World Trade Organization. "Financial Services: Background Note by the Secretariat." S/C/W/72 (98-4837). Geneva: World Trade Organization, December 1998.

_____. "GATS—Fact and Fiction." Geneva: World Trade Organization, 2001.

_____. "Presence of Natural Persons (Mode 4): Background Note by the Secretariat." S/C/W/75 (98-4927). Geneva: World Trade Organization, December 1998.

Yuskavage, Robert E., Erich H. Strassner and Gabriel W. Medeiros. "Outsourcing and Imported Services in BEA's Industry Accounts." Washington, D.C.; Bureau of Economic .... Analysis. Paper prepared for the National Bureau of Economic Research Conference on Research in Income and Wealth. Presented at the Conference on International Service Flows. Bethesda, MD, April 2006.

Zagada Institute. Caribbean Call Center Report 2002. Zagada Markets, Inc., 2002.

Zavodny, Madeline. "The H-1B Program and its Effects on Information Technology Workers." Federal Reserve Bank Atlanta *Economic Review*, Issue 3, 2003.

Zeile, William J. "Operations of U.S. Affiliates of Foreign Companies: Preliminary Results from the 2002 Benchmark Survey." Survey of Current Business (August 2004): 192-217.

NATIONAL ACADEMY OF
PUBLIC ADMINISTRATION®

1100 New York Avenue, N.W.
Suite 1000 East
Washington, DC 20005
Phone: (202) 347-3190
Fax: (202) 393-0993
Web: www.napawash.org