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Globalization and Offshoring of Software

A Report of the ACM Job Migration Task Force

William Aspray, Frank Mayadas, and Moshe Y. Vardi, Editors

Association for Computing Machinery
Advancing Computing as a Science & Profession

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Globalization and Offshoring of Software
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Foreword

For the past six decades, the Association for Computing Machinery (ACM) has been an integral part of the evolution of computing as a science and profession. In early 2004, ACM members began expressing concern about the future of computing as a viable field of study and work. There were daily stories in national and international media describing major shifts in employment that were occurring largely as a result of offshoring. Combined with the impact of the end of the dot.com boom, these reports raised more questions than they answered in the minds of many ACM members.

Given these concerns, ACM Council commissioned a Task Force to look at the facts behind the rapid globalization of IT and the migration of jobs resulting from outsourcing and offshoring. Being an international organization, ACM expected the task force to look at the issue from a global perspective, as compared to a country-centric one. This was not intended to be a study of offshoring from the United States to India and China and the impact of that offshoring on the computing profession in the United States. Instead, the task force was charged with looking at the forces shaping the migration of jobs worldwide in the computing and information technology fields. Prior to this effort, no study has looked at offshoring on a global scale.

ACM Presidents Maria Klawe (2002-04) and David Patterson (2004-06) invited Frank Mayadas of the Sloan Foundation, Moshe Y. Vardi of Rice University, and Bill Aspray of Indiana University to lead the effort. This group commissioned a task force of computer scientists, social scientists, and labor economists from around the world. The Task Force held four in-person meetings at which the facts and data surrounding the issue were presented and discussed. In the process, trends emerged, myths were debunked, and a more realistic picture of the current state and likely future of the information technology field, profession, and industry emerged.

The report resulting from this study is significant. Moreover, the annotated bibliography available on the ACM Web site provides the most comprehensive list of reports, resources, and papers assembled on the topic of offshoring. As described in detail in the eight chapters that comprise the report, the field of computing and information technology has experienced a dramatic shift in the past five years to a truly global industry. The forces that have driven and shaped this change are still at play and will continue. The implications for every ACM member are significant. Full participation in the systems, software, and services portion of the global information technology field will require deep grounding in the fundamentals of computing, new knowledge surrounding business processes and platforms, and a deeper understanding of the global community in which work will be done. The educational systems that underpin our profession will need to change.

The future of IT is exciting, but it is a future very different from the past, and even from the present.

John R. White

ACM Chief Executive Officer

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Executive Summary and Findings

Why this Study?

This study reports on the findings of a Task Force established by The Association for Computing Machinery (ACM) to look at the issues surrounding the migration of jobs worldwide within the computing and information technology field and industry. ACM initiated this study to provide a deeper understanding of the trends in, and the forces behind, the globalization and offshoring of software. Because ACM is an international educational and scientific computing society, the study approached the issue of offshoring of software from an international as opposed to a United States-centric perspective. Moreover, the task force that conducted the study comprised not only computer scientists (ACM's traditional constituency) but also labor economists and social scientists from around the world. We believe that this approach, and this perspective, are unique. Most reports on globalization and offshoring are produced either by governments or national organizations, and thus provide an inherently national perspective, or by consulting firms in pursuit of their own or their clients' business interests.

The primary purpose of the study is to provide ACM's 83,000 members, the computing field, the IT profession, and the public an objective perspective on current and future trends in the globalization of the software industry so that ACM members can better prepare themselves for a successful future in the system, software, and services portion of the global information technology field. We also believe this extensive study will be of value to those shaping the policies, priorities, and investments any country must make if it desires to remain or become a part of the global software-systems-services industry.

Scope of the Study

This study reports on the current state of globalization and offshoring of software and related information technology (IT) services. (*Outsourcing* refers to having work for a company done by another organization. *Offshoring* refers to having this work done in another country, whether or not it is done by part of the same company.)

The report is focused primarily on software systems work carried out in developing countries for export, as opposed to work done in a developing country for their local market. The ACM Task Force reviewed existing reports and data from around the world, and heard in-person from many experts, on issues relevant to globalization and offshoring. In the process, the Task Force took an in-depth look at the following:

1. The economic theories and data that underpin our current understanding of the forces shaping globalization today and in the future.
2. Offshoring from the perspective of different countries—both developed and developing.
3. Offshoring from the perspective of different types of corporations.
4. The globalization of computing research.
5. The risks and exposure that offshoring engenders.
6. The implications for educational systems throughout the world.

7. The political responses to the opportunities and disruptions that accompany globalization.

Each of these areas is explored in detail in a chapter of the report.

Findings and Recommendations

In reviewing many existing reports, data, theories, and perspectives, a number of key findings and recommendations emerged.

1. Globalization of, and offshoring within, the software industry are deeply connected and both will continue to grow. Key enablers of this growth are information technology itself, the evolution of work and business processes, education, and national policies.

The world has changed. Information technology is largely now a global field, business, and industry. There are many factors contributing to this change, and much of this change has occurred within the past five years. Offshoring is a symptom of the globalization of the software-systems-services industry.

This rapid shift to a global software-systems-services industry in which offshoring is a reality has been driven by advances and changes in four major areas:

1. *Technology*—including the wide availability of low-cost, high-bandwidth telecommunications and the standardization of software platforms and business software applications.
2. *Work processes*—including the digitalization of work and the reorganization of work processes so that routine or commodity components can be outsourced.
3. *Business models*—including early-adopter champions of offshoring, venture capital companies that insist the companies they finance use offshoring strategies to reduce capital burn rate, and the rise of intermediary companies that help firms to offshore their work.
4. *Other drivers*—including worldwide improvements in technical education, increased movement of students and workers across national borders, lowering of national trade barriers, and the end of the Cold War and the concomitant increase in the number of countries participating in the world market.

2. Both anecdotal evidence and economic theory indicate that offshoring between developed and developing countries can, as a whole, benefit both, but competition is intensifying.

The economic theory of comparative advantage argues that if countries specialize in areas where they have a comparative advantage and they freely trade goods and services over the long run, all nations involved will gain greater wealth. As an example, the US and India have deeply interconnected software industries. India benefits from generating new revenue and creating high-value jobs; the US benefits from having US-based corporations achieve better financial performance as a result of the cost savings associated with offshoring some jobs *and* investing increased profits in growing business opportunities that create new jobs. This theory is supported to some extent by data from the US Bureau of Labor Statistics (BLS). According to BLS reports, despite a significant increase in offshoring over the past five years, more IT jobs are available today in the US than at the height of the dot.com boom. Moreover, IT jobs are predicted to be among the fastest-growing occupations over the next decade.

Some economists have recently argued that in certain situations offshoring can benefit one country at the expense of another. While debate continues about this aspect of theory/policy, the majority of the economic community continues to believe that free trade is beneficial to all countries involved, though some argue that globalization may lead to technology leaders' losing their current dominant position.

In any event, economists agree that even if a nation as a whole gains from offshoring, individuals and local communities can be harmed. One solution to this potential negative impact is for corporations or their governments to provide programs that aid these individuals and their related communities in once again becoming competitive. The cost of such "safety-net" programs can be high and, thus, difficult to implement politically.

3. **While offshoring will increase, determining the specifics of this increase is difficult given the current quantity, quality, and objectivity of data available. Skepticism is warranted regarding claims about the number of jobs to be offshored and the projected growth of software industries in developing nations.**

Data for making good decisions about offshoring are difficult to obtain. Government data as collected are not very helpful and do not adequately address the specific issue of offshoring. The objectivity and quality of other data sources, especially the data in reports from consulting firms and trade associations, is open to question, as these organizations may be serving their own agendas. Projections are always more suspect than data on current employment levels.

It is very difficult to determine how many jobs are being, or will be, lost due to offshoring. The best data available are for the United States. Some reports suggest that 12 to 14 million jobs are vulnerable to offshoring over the next 15 years. This number is, at best, an upper limit on the number of jobs at risk. To date, the annual job loss attributable to offshoring is approximately 2 to 3 percent of the IT workforce. But this number is small compared with the much higher level of job loss and creation that occurs every year in the United States.

Thirty percent of the world's largest 1000 firms are offshoring work, but there is a significant variance between countries. This percentage is expected to increase, and an increase in the amount of work offshored is consistent with the expected growth rate of 20 to 30 percent for the offshoring industries in India and China. Almost all estimates are based on reports from national and international consulting firms and, thus, subject to scrutiny.

4. **Standardized jobs are more easily moved from developed to developing countries than are higher-skill jobs. These standardized jobs were the initial focus of offshoring. Today, global competition in higher-end skills, such as research, is increasing. These trends have implications for individuals, companies, and countries.**

The report considers several case studies of firms and how they are addressing offshoring, including software service firms in low-wage nations and four types of firms in high-wage nations: packaged software firms, software service firms, entrepreneurial start-up firms, and established firms outside the IT sector. These cases show that the amount and diversity of work being offshored is increasing; and companies, including start-ups, are learning how to access and use higher skill levels in developing countries.

One example of a higher-skill area now subject to global competition is computing research. Historically, the bulk of this research was carried out in only a few countries - countries with high purchasing-power-parity adjusted gross domestic product (PPP GDP) and with a relatively large percentage of PPP GDP devoted to research and development. This situation is changing rapidly and the trend looks inexorable. Many companies have established research centers in multiple countries. Most of these companies retain strong research operations in their home country. This fact, combined with increasing national research investment in India and China, is leading to both an increase in the total worldwide investment in research and a wider distribution of research activities around the world.

People are by far the most important asset in research. The historic advantage held by Western Europe and the United States is not as strong today as in the past, given the developments in the graduate education systems in China and India, increased opportunities for research careers in those countries, and the rising national investment in research. The United States, in particular, faces a challenge in its inability to recruit and retain foreign students and researchers in the numbers it did in the past. Its dominance in the research area is likely, therefore, to be challenged.

Finally, while there is no way of ensuring lifetime IT employment, there are steps that students and IT workers can take to improve their chances of long-term employment in IT occupations. These include obtaining a strong foundational education, learning the technologies used in the global software industry, keeping skills up to date throughout their career, developing good teamwork and communication skills, becoming familiar with other cultures, and managing their careers so as to choose work in industries and jobs occupations less likely to be automated or sent to a low-wage country.

5. Offshoring magnifies existing risks and creates new and often poorly understood or addressed threats to national security, business property and processes, and individuals' privacy. While it is unlikely these risks will deter the growth of offshoring, businesses and nations should employ strategies to mitigate them.

When businesses offshore work, they increase not only their own business-related risks (e.g., intellectual property theft, failures in longer supply chains, or complexity arising from conflicting legal environments) they also increase risks to national security and individuals' privacy. Businesses have a clear incentive to manage these new risks to suit their own interests, but nations and individuals often have little awareness of the exposures created. For example, many nations have adopted commercial off-the-shelf (COTS) software and Internet Protocol technologies in IT-based military systems and critical infrastructure systems. Many COTS systems are developed, in part or whole, offshore, making it extremely difficult for buyers to understand all source and application code. This creates the possibility that a hostile nation or non-governmental hostile agents (terrorist/criminal) can compromise these systems. Individuals often are exposed to loss of privacy or identity theft. Bank records, transaction records, call center traffic, and service centers all are being offshored today. Voluminous medical records are being transferred offshore, read by clinicians elsewhere, stored and manipulated in foreign repositories, and managed under much less restrictive laws about privacy and security than in most developed countries.

These risks can be managed by companies and governments through the use of risk mitigation strategies. For example, businesses should minimize access to databases by offshore operations and encrypt data transmissions; offshoring providers should be vetted carefully; companies should have security and data privacy plans and be certified to meet certain standards; and service providers should not outsource work without the explicit approval of the client. Nations can adopt stronger privacy policies, invest in research methods to secure this data, or work on the development of nation-to-nation and international treatment of both the data and how compromises will be handled.

6. **To stay competitive in a global IT environment and industry, countries must adopt policies that foster innovation. To this end, policies that improve a country's ability to attract, educate, and retain the best IT talent are critical. Educational policy and investment is at the core.**

Building a foundation to foster the next generation of innovation and invention requires

- Sustaining or strengthening technical training and education systems,
- Sustaining or increasing investment in research and development, and
- Establishing governmental policies that eliminate barriers to the free flow of talent.

Education is one of the primary means for both developed and developing countries to mount a response to offshoring so their workforces can compete globally for IT jobs. In fact, education has been a primary enabler of offshoring in the developing countries. India has responded rapidly to the educational needs of its software export industry, especially through its private universities and training organizations. China is addressing the educational needs of its software industry through centralized planning.

There are, however, problems with both the Indian and Chinese educational systems. India provides poor quality higher education outside its top tier of universities, the quality of the faculty is uneven, research opportunities are not generally available to either students or faculty, and there is a tension between providing a good education to a limited number of people and providing access for all. The Chinese system is burdened with an emphasis on rote learning, a reward system for faculty that has not yet been transformed fully to reward research by faculty and their students, and problems moving from a central planning to a competitive funding system that rewards merit and entrepreneurship.

Developed nations can use education as a response to offshoring in order to protect national interests. It can, however, be complex for a nation to address offshoring through education for several reasons: educational systems are complex, with multiple degrees and multiple majors preparing one for an IT career; the nature of the software work that is being offshored is changing rapidly; it is difficult to forecast national supply and demand needs for software workers; governments can only indirectly affect supply and demand in many nations; and it is difficult to translate an educational response to offshoring into practical curriculum reform. For example, the United States educational system is still trying to understand how to change its curriculum to address application domain knowledge, a global workplace, and maintaining its innovative edge. In addition, the United States faces long-term challenges from falling interest and skills in math and science programs in its primary education system. The European Union is struggling with the implementation of the Bologna Directive to achieve a single European educational framework.

There are some general principles that all countries can follow to mount an effective educational response to offshoring:

1. Evolve computing curriculum at a pace and in a way that better embraces the changing nature of IT.
2. Ensure computing curriculum prepare students for the global economy.
3. Teach students to be innovative and creative.
4. Evolve curriculum to achieve a better balance between foundational knowledge of computing on the one hand, and business and application domain knowledge on the other.
5. Invest to ensure the educational system has good technology, good curriculum, and good teachers.

Conclusion

Globalization of, and offshoring within, the software industry will continue and, in fact, increase. This increase will be fueled by information technology itself as well as government action and economic factors and will result in more global competition in both lower-end software skills and higher-end endeavors such as research. Current data and economic theory suggest that despite offshoring, career opportunities in IT will remain strong in the countries where they have been strong in the past even as they grow in the countries that are targets of offshoring. The future, however, is one in which the individual will be situated in a more global competition. The brightness of the future for individuals, companies, or countries is centered on their ability to invest in building the foundations that foster innovation and invention.

Introduction

In the spring of 2004 we were asked by the Association of Computing Machinery (ACM) to chair a task force to study the phenomenon of information-technology offshoring. Offshoring was a hot topic in early 2004. Since the dot-com and telecommunication crashes of the early 2000s, offshoring appears to be the proverbial "third shoe" to hit the IT sector in the United States. While articles on offshoring and outsourcing appeared in the media weekly, sorting out facts from fiction was exceedingly difficult. While it was clear that offshoring was a boon to providers in developing countries, debates raged on its impact on developed countries. Getting a clear, factual picture of IT offshoring was undeniably important and timely.

ACM offered us a free reign in conducting this study, subject to two constraints. First, the study had to look at offshoring from a global perspective, reflecting ACM's position as an international organization. Previous studies of offshoring have typically taken a national, usually American, perspective. Second, the study had to be completed roughly within one year, which implied that it had to be a secondary study, based on published material, rather than a primary study, doing its own collection of data. Early on we decided to focus on the software side of IT. Offshoring of IT manufacturing has been going on for a number of years; the phenomenon that took off during the early 2000s was the offshoring of software.

Our hope is this report sheds much-needed light on software offshoring. It points out that offshoring is a symptom of globalization, which has been an inexorable economic force since 1990, while examining the specific forces that drive software offshoring, both at the country level and at the firm level. It surveys the debate on the economic impact of offshoring, and examines the available data, pointing out the paucity of reliable relevant data. The report also shows how IT research has been leading the offshoring trend. It highlights risks and exposures to individuals, corporations, and countries created or magnified by offshoring. Finally, it portrays the opportunities and challenges that offshoring poses to IT education in both developing and developed countries.

The Task Force was assembled during the second half of 2004. Bill Aspray, who has experience with work force studies, agreed to serve as executive consultant and primary editor for this study; indeed, it could not have been carried out without him. To ensure a broad perspective, we recruited around 30 Task-Force members, computer scientists, economists and sociologists from the US, Europe, Israel, India and Japan (see listing below and biographies). We are grateful to all of them for volunteering their time and efforts.

The Task Force held four meetings: in Chicago, IL, Oct. 8-9, 2004; Washington, DC, Dec. 3-4, 2004; Palo Alto, CA, March 4-5, 2005; and New York, NY, May 13, 2005. During it first meeting, the Task Force scoped the study, decided what the main topics should be, and divided into several committees, with some members serving on more than one. Roughly, each committee was focused on one topic, which is covered by one chapter in the final report. The next two meetings were dedicated to hearing perspectives by many experts and scholars (listed below), while committees continued their work during and between the meetings. At the final meeting, the committees presented drafts of their reports and received feedback from the rest of the Task Force.

The committees prepared the final drafts of their reports during the summer of 2005. These drafts went then to Aspray for editing. The edited versions were then sent to reviewers; each chapter was vetted by several reviewers. The process of review and revision continued through the fall of 2005.

During its work, the Task Force has reviewed hundreds of articles on the subject of offshoring, and IT offshoring in particular. To aid the Task Force in its work, Aspray prepared an extensive annotated bibliography. While this bibliography is too extensive to be included in the printed report, ACM is making it available online (http://www.acm.org/globalizationreport) as a service to its members.

We appreciate the efforts of the many individuals who helped the Task Force carry out its work.

Frank Mayadas and Moshe Y. Vardi

Task Force Co-Chairs, December 2005.

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Overview

1. The Big Picture

Over the past decade, low-wage countries such as India have developed vibrant, export-oriented software and IT service industries. Attracted by available talent, quality work, and most of all low cost, companies in high-wage countries, such as the United States and the United Kingdom, are increasingly offshoring software and service work to these low-wage countries. Trade (together with automation) cost many jobs in the manufacturing sector to be lost from the West and many developing nations in East Asia to increase their wealth and industrial prowess since 1970. Changes in technology, work organization, educational systems, and many other factors have caused service work—previously regarded as immune to these forces—also to become tradable. This trade in services, led by the trade in software and IT-enabled services, presents many opportunities and challenges for individuals, firms, and policymakers in both developed and developing nations.

Many people in the United States and Western Europe fear that sending software work offshore will cause wage and job suppression in the high-wage countries. Others believe that the process of getting good labor at lower prices will make the economy more productive, enabling the creation of new wealth and new jobs. Many people in the low-wage countries are excited by the economic development that their software and service industries are bringing them; while some are concerned about the side effects such as congestion, pollution, and loss of traditional cultural values. One thing that is clear is that the globalization of software is here to stay, so that policymakers, educators, and employers all need to address the realities of offshoring. This includes, for example, how to help people whose jobs are shipped to another country to get assistance with their careers, how to create innovative environments that help to create new jobs, and how to revamp educational systems for the realities of a globalized world.

"Offshoring" is the term used here. It is a term that applies best to the United States because, even though the United States does outsource work to Canada and Mexico, most of its work is sent over the seas—mostly to India, but also to China, Malaysia, the Philippines, and many other places. Germany, for example, also sends work across its borders, including to Eastern Europe, but there is no water—no shore—to cross. Some of the work that is offshored is sent to entrepreneurial firms established in these low-wage countries. Other times, multinationals headquartered in high-wage countries open subsidiaries in the low-wage countries to work on products and services for their world market. Multinationals may also open facilities in these low-wage countries in order to better serve the local market there, but that situation is not the primary interest of this study.

There are at least six kinds of work sent offshore related to software and information technology: (1) programming, software testing, and software maintenance; (2) IT research and development; (3) high-end jobs such as software architecture, product design, project management, IT consulting, and business strategy; (4) physical product manufacturing—semiconductors, computer components, computers; (5) business process outsourcing/IT Enabled Services—insurance claim processing, medical billing, accounting, bookkeeping, medical transcription, digitization of engineering drawings, desktop publishing, and high-end IT enabled services such as financial analysis and reading of X-rays; and (6) call centers and telemarketing. Our primary interest is with the first three of these categories, which are the ones most closely associated with the transfer of software work across national boundaries. However, it is almost impossible to study offshoring without at least at times considering the other three categories of work as well. This is because companies that do one of these kinds of software work may also do several other kinds of offshore work as part of their product and service line of offerings; and companies that send work offshore may send work of several kinds. Because companies and industries intermingle these categories of work, so does most statistical data that tracks this industry—and it is often impossible to disaggregate data to capture information about only the categories of work of greatest concern here. Thus we focus on the first three categories but discuss the others in passing.

The countries that send work offshore are primarily developed nations. The United States followed by the United Kingdom have been the largest offshorers, but other countries in Western Europe, Japan, Korea, Australia, and even India send work offshore. The countries that do the work fall into four categories: (1) those that have a large capacity of highly educated workers and have a low wage scale (e.g., India, China); (2) those that have special language skills (e.g., the Philippines can serve the English and Spanish customer service needs of the United States by being bilingual in these languages); (3) those that have geographic proximity ("nearsourcing"), familiarity with the work language and customs, and relatively low wages compared to the country sending the work (e.g. Canada accepting work from the United States, the Czech Republic accepting work from Germany); and (4) special high-end skills (e.g., Israeli strength in security and anti-virus software).

There are many drivers and enablers of offshoring. These include: (1) The dot-com boom years witnessed a rapid expansion of the telecommunications system, making ample, low-cost broadband available in many countries at attractive rates. This made it possible to readily transfer the data and work products of software offshoring. (2) Software platforms were stabilized, with most large companies using a few standard choices: IBM or Oracle for database management, SAP for supply chain management, and so on. This enabled offshoring suppliers to focus on acquiring only these few technologies and the people who are knowledgeable about them. (3) Companies are able to use inexpensive commodity software packages instead of customized software, leading to some of the same standardization advantages as with software platforms. (4) The pace of technological change was sufficiently rapid and software investments became obsolescent so quickly that many companies chose to outsource IT rather than invest in technology and people that would soon have to be replaced or retrained. (5) Companies felt a competitive need to offshore as their competition began to do so. (6) Influential members from industry, such as Jack Welch from General Electric, became champions of offshoring. (7) Venture capitalists pushed entrepreneurial startups to use offshoring as a means to reduce the burn rate of capital. (8) New firms emerged to serve as intermediaries, to make it easier for small and medium-sized firms to send their work offshore. (9) Work processes were digitalized, made routine, and broken into separable tasks by skill set—some of which were easy to outsource. (10) Education became more globally available with model curricula provided by the professional computing societies, low capital barriers to establishing computer laboratories in the era of personal computers and package software, national plans to build up undergraduate education as a competitive advantage, and access to Western graduate education as immigration restrictions were eased. (11) Citizens of India and China, who had gone to the United States or Western Europe for their graduate education and remained there to work, began to return home in larger numbers, creating a reverse Diaspora that provided highly educated and experienced workers and managers to these countries. (12) India has a large population familiar with the English language, the language of global business and law. (13) India has accounting and legal systems that were similar to those in the United Kingdom and the United States. (14) Global trade is becoming more prevalent, with individual countries such as India and China liberalizing their economies, the fall of Communism lowering trade barriers, and many more countries participating in international trade organizations.

At first it was believed that the only software work that would be offshored was low-level work, such as routine software maintenance and testing, routine business office processes, and call centers. Offshoring suppliers, however, have made strong efforts to move up the value chain and provide services that have higher value added because this is where there is the greatest opportunity for profit. Research and development, project integration, and knowledge process outsourcing such as reading X-rays and doing patent checking are increasingly being offshored. Today, some people believe that any kind of software or IT-enabled work can be offshored. While there is an element of truth in this belief, there are some important caveats. Some kinds of work have not been offshored. Even if it is possible to offshore a particular type of work, it does not mean that every job of that type actually will be offshored. In fact, there are a number of reasons why a company might not wish to offshore work: (1) the job process has not been made routine. (2) The job cannot be done at a distance. (3) The infrastructure is too weak in the vendor country. (4) The offshoring impacts too negatively on the client firm such as the client firm losing control over an important work element, losing all its in-house expertise in an area, or too high a loss of worker morale in the client firm. (5) Risks to privacy, data security, or intellectual property are too high. (6) There are not workers in the supplier firm with the requisite knowledge to do the job, which happens for example when the job requires application domain knowledge as well as IT knowledge. (7) Costs of opening or maintaining the offshore operation are too expensive. (8) There are cultural issues that stand between the client and vendor. (9) The company can achieve its goal in another way, such as outsourcing within its home country or consolidating business operations.

One might wonder whether IT is still a good career choice for students and workers in countries that offshore software and IT services work. Despite all the publicity in the United States about jobs being lost to India and China, the size of the IT employment market in the United States today is higher than it was at the height of the dot-com boom. Information technology appears as though it will be a growth area at least for the coming decade, and the US government projects that several IT occupations will be among the fastest growing occupations during this time. There are some things that students and workers in this field should do to prepare themselves for the globalized workplace. They should get a good education that will serve as a firm grounding for understanding the rapidly changing field of IT. They should expect to participate in life-long learning. They should hone their "soft skills" involving communication, management, and teamwork. They should become familiar with an application domain, especially in a growth field such as health care, and not just learn core technical computing skills. They should learn about the technologies and management issues that underlie the globalization of software, such as standard technology platforms, methods for re-using software, and tools and methods for distributed work.

2. The Economics of Offshoring

Much of the economic debate about offshoring centers around whether the theory of comparative advantage applies to the offshoring of software and IT services. Economists have argued on both sides of the issue. The arguments are sophisticated and nuanced, and the results often depend on whether the underlying assumptions hold in the current context. While a majority of economists are proponents of free trade, the underlying question is an empirical one and can be answered by analyzing reliable data when it becomes available.

The theory of comparative advantage states that if each country specializes in the production of goods where it has a comparative (relative) advantage, both countries can enjoy greater total consumption and well being in aggregate by trading with each other. Offshoring enables, for example, US firms to lower costs and save scarce resources for activities in which they have a relative advantage, while offshoring has led to significant employment and wage gains for Indian workers and rapid profit and revenue increases for Indian businesses.

What the theory of comparative advantage does *not* mean is that all members of society will benefit from trade. In general, imports of an "input" have economic effects that are similar to those of an increase in the supply of the input, namely, lower returns to the suppliers of the input, lower costs of production, and lower prices for consumers. If the input were a service, the wages and salaries of those producing the service would fall, but so also would costs for firms that are buyers of the service. In the exporting country, the opposite effects hold. That is, the returns to the owners or suppliers of the service or input increase and the wages of the employees at the service providers increase due to the higher demand.

Economists believe that trade generally leads to significant gains for society. These gains are not inconsistent with employment losses in specific sectors that will cause economic pain to the workers affected. To achieve an equitable result, many analysts believe that it is important to establish a safety net that provides income and training opportunities to affected workers. Components of the safety net might include extended unemployment benefits, wage insurance, and retraining.

A key assumption underlying the theory of comparative advantage is that the economy enjoys *full employment*. Thus, this theory is best thought of as a theory of the long-term, in which workers displaced by imports or offshoring find work in other sectors. By contrast, most popular discussions of the offshoring phenomenon tend to focus on questions such as "where will the new jobs be created" and "can the workers be retrained for these new jobs". In general, peering into the crystal ball to predict where and what types of new jobs will be created is both difficult and unrewarding. A dynamic economy such as that of the United States creates and destroys millions of new jobs in response to changes in tastes, and more importantly in response to innovations and advances in technology. There is no guarantee that the economy will continue to create these new jobs, but policy makers can take some comfort from the historical evidence that thus far it has managed to do so. The key to job creation is of course the ability of the economy to rapidly generate and adopt innovations—new types of goods and services, and productivity-enhancing process improvements.

In general, trade stimulates innovation and economic growth in both trading partners. Some, such as Ralph Gomory and Gregory Baumol, have argued that innovation opportunities create new possible conflicts of interest between trading partners. For example, insofar as offshoring stimulates, in countries such as China, innovation and productivity growth in goods and services where developed countries such as the United States enjoy a comparative advantage, this will cause the "terms of trade" to become less favorable over time for the United States. In other words, even if free trade is the best policy, it may well be that free trade, by stimulating innovation overseas, may impose long-term losses. However, Gomory and Baumol's analysis shows that this conflict of interest is present when the two trading partners are at similar stages of development. Since most offshoring involves countries at very different levels of development, this conflict of interest is presently unlikely.

In the IT services sector, there is a related concern. Currently, it is efficient to offshore "low-end" IT services, such as coding or maintenance, to a low-wage country while "high-end" activities, such as requirements analysis, design, and R&D, remain in the high-wage country. The concern is, however, that eventually the high-end IT activities would also move offshore. Were this to happen, the current technology leaders (United States, Germany, Japan, United Kingdom, et al.) may relinquish that leadership role. There is some anecdotal evidence that some IT process innovations are moving to low-wage, offshoring operations.

Most economists, however, argue that current technology leaders will not lose their technological leadership position. Even if production moves to other countries, history shows that in many industries the locus of production and the locus of invention are physically separated. There are two key resources required to remain at the center of innovation in software: access to talented designers, software engineers, and programmers; and proximity to a number of large and technically sophisticated users. Current technology leaders, and the United States in particular, currently dominate on both counts. More broadly, the United States has other important capabilities, including the best universities and research institutions, highly efficient capital markets, flexible labor markets, the largest consumer market, business-friendly immigration laws, and a large and deep managerial talent pool. As a result, the evolution of business in the United States has followed a consistent pattern: launch innovative businesses here, grow the business, and as products and services mature migrate lower-value-added components and intermediate services over time to lower-cost countries. Nevertheless, there are those who argue that globalization will diminish the comparative advantage of current technology leaders, which may lead to the loss of their current dominant position and create a long period of adjustment for their workers.

Data on current and future trends of offshoring leave much to be desired. First, the definitions of offshoring vary from one study to another, making it hard to compare statistics. For example, some studies count all service jobs, some count IT jobs, some include IT-enabled jobs, and some are simply not precise about what they are counting. Second, there is a question of what metric to use in measuring the extent and trends in offshoring. One might measure, for example, jobs lost in the developed country, jobs in the developing country's IT industry, or dollar value of business outsourced. In the case of each of these metrics, however, it is either difficult to make the measurement or the metric is not directly enough relevant to the offshoring situation. For example, it is difficult to calculate dollar value of business offshored because these are internal transfer costs for multinationals, which they may not be willing to report or do not report in an appropriately disaggregated way.

Projections of future trends are more suspect than data on the current situation. One type of projection identifies types of jobs that are vulnerable to offshoring. These vulnerability projections provide at best a high upper bound on expected job loss, and for this reason they are blunt policy-making tools. It may be that routine programming jobs are vulnerable to offshoring, but it is highly unlikely that every last one of them will be lost to offshoring. Moreover, even in cases where the methodology is sound and soundly applied, projections of any kind about the future are much less likely to be accurate than data about today's or yesterday's situation since it is difficult to predict all the factors that will come into effect over time.

Another important issue to consider is the source of the data. Data from the United States and many other national governments tends in general to be reliable. The US government, however, collects data to handle established policy issues. If a new phenomenon arises, the existing data sets may not be well suited to studying the new policy issue. This is the case with offshoring. US data on job layoffs and on service trade are both designed for other purposes, and there is widespread belief among economists that both seriously undercount offshoring trends. Data collected and analyzed by trade associations and consulting firms may be very useful, but there is skepticism in the economic community about the quality of these data in many cases because the methods for collecting and analyzing the data are often not made available for scrutiny, the data they collect (from members of their organization) may not be a representative sample of society as a whole, and these organizations have particular objectives in mind that they hope their data will bolster.

The United States is the source of the greatest number of offshored jobs and where the phenomenon has received the greatest attention. But even for the US, it is difficult to be certain of the extent of offshoring. Federal data is not very helpful, and most of the existing data comes from consulting firms. The numbers generally indicate that 12 to 14 million jobs in the United States are vulnerable to relocation through offshoring, and that annual losses have ranged from under 200,000 to about 300,000 service jobs from the United States to offshoring. The number of IT jobs is somewhat lower than these estimates because these estimates include service jobs such as working in call centers and sometimes other IT-enabled services such as business process and knowledge process offshoring. Importantly, these estimates do not include newly created jobs. The consensus seems to be that about 20% of US companies are currently offshoring work but that the percentage is rising. The current value of offshoring contracts from the United States seems to be in the $10 to 20 billion range, with an expectation of rapid growth. It should be remembered, however, that we do not know the methods used to arrive at these numbers and how independent the data from one consulting firm's study is from that of another.

Statistics for the entire world or for other individual countries are even harder to come by and more suspect than those for the United States. The annual dollar value of worldwide offshoring trade for recent years has been estimated to be between $1.3 billion and $32 billion, depending on whether certain exported products are counted and whether the numbers for multinational companies are included. An estimated 30% of the world's largest 1000 firms are offshoring work. Europe has lower levels of offshoring than the United States. It is estimated that only 5% of European businesses (of all sizes) are offshoring, and at most 2 to 3% of European IT workers will lose their jobs to offshoring by 2015. The United Kingdom has the highest rate of work sent offshore of any European nation, with an estimated 61% of firms now offshoring. In Germany, only 15% of companies are now offshoring, and perhaps a total of 50,000 German jobs have been lost to offshoring so far; however, there seems to be an increase in German offshoring in the recent past. Statistics about India show a vibrant IT industry, with annual growth of 20 to 30%, the vast majority of the growth coming in the export rather than the domestic market. Data on the rest of the world are too spotty to trust.

3. Understanding Offshoring from a National Perspective

The first countries to develop software industries primarily for export rather than domestic purposes were Ireland and Israel. The big player to come in a little later was India, beginning in the mid-1970s and growing rapidly from the late 1990s. To some degree, a global division of labor is beginning to form: India serving the English-speaking world, Eastern Europe and Russia serving Western Europe, and China serving Japan. But India is also providing service to Western Europe, and China provides service to the United States. In addition, there are many smaller supplier countries. The greatest attention is given in this report to the United States and India, the two biggest players.

The United States has historically dominated and continues to dominate the software and services industry, with about 80% of global revenue. It is highly dominant in the packaged services industry, with 16 of the top 20 companies worldwide, and slightly less commanding but still dominant in the software services sector, with 11 of the top 20 companies. This dominance is due to a number of factors, including a legacy of government funding of R&D,

computer science research in the open US higher education system, early adoption by sophisticated users, the world's largest economy and market, and leading semiconductor and data storage industries that helped to spread the use of computing.

The centrality and dominance of the US industry has been a given during the past five decades. What is emerging is the globalization of the software and software services industry. This creates opportunities around the world for people and companies in both developed and developing countries to participate in this profitable industry. It also creates challenges for the former leaders, notably the United States, Western Europe, and Japan.

Software services is India's largest export. As a large developing nation, India faces many challenges, including high rates of poverty, corruption, and illiteracy; a substandard infrastructure; excess government regulation; and various other problems typical of a poor nation. These challenges are offset by a number of strengths, especially for software and services production. It has a long history of developing capable mathematicians. India is unique because of the large number of individuals with adequate English language capability, and also for the large cadre of Indian managerial and technical professionals working in North American and, to a lesser degree, in European high-technology occupations and organizations. For those who can afford it, India has a strong and highly competitive K-12 educational system emphasizing science and mathematics. Despite its democratic socialist tradition that involved large amounts of bureaucracy and state regulation, it has been a market economy and has a history of managerial education and competence. These assets have given India many advantages in establishing a software export industry.

India's software export industry began in 1974, when it began sending programmers to the United States to do work for the Burroughs Corporation. Political liberalizations related to trade in the 1970s and again in the early 1990s helped to support the development of the Indian software industry. Offering solutions to the Y2K problem helped the industry to grow substantially. The industry expanded beginning in the late 1990s, first by bringing back to India much of the software development, maintenance, and testing work it had previously done on the client's premises, then developing export businesses in business process offshoring, call centers, and research and development. India is moving up the value chain and is seeking people with considerably more skill than low-level programmers to do these higher value jobs. Software and service export firms in India are growing at 20 to 25% per year according to the best statistics available, and each of the three leading Indian software firms (Infosys, TCS, and Wipro) already employs over 40,000 people.

India is likely to continue to grow its software industry in scale, scope, and value-added. There is little reason to believe that offshoring as a process will end in the foreseeable future, but it could slow down. The enormous investment by leading software multinationals will expand the number of Indian project managers with strong managerial skills. This, together with the relocation of portions of startup firms to India, is likely to result in greater levels of entrepreneurship and lead to firms able to sell their skills on the global market. The offshoring of IT services and software for export will dominate the near future of the Indian software industry. There are several possible trajectories. Custom projects could become more complex and large, leading Indian software professionals to move from programming into systems integration and systems specification and design. The average size of projects Indian firms are undertaking has already grown from 5 person-years in 1991 to 20 person-years in 2003. As multinationals deepen their Indian operations, domain skills are developing in India and some other nations, so that managed services are likely to become more important; this will match global trends in the outsourcing of applications management and business processes.

Despite the fact that India's software production for the US market exceeds that of any other nation, it holds only a small share of the global market for all software value-added. The only part of the software value chain in which India has made substantial inroads is in applications development, where it has captured 16.4 percent of the world market. But applications development is only approximately 5 percent of the entire global software services market. This implies that there is much room for growth. In order to grow, the Indian industry will have to shift to more complex activities by securing larger projects, undertaking engineering services, integrating and managing services, or bidding on projects that include transforming a client's entire work process. India, however, will have some difficulty achieving this growth unless it strengthens its R&D capability.

Software offshoring to India is likely to grow, not only through the continued growth of indigenous Indian firms, but also because foreign software firms are increasing their employment in India in product development and particularly in software services. Competition is likely to grow between multinationals based in developed countries, such as Accenture, IBM, and Siemens Business Services, and the large Indian firms, such as HCL, Infosys, TCS, and Wipro, as the Indian companies expand their global reach and the multinationals expand their operations in low-cost countries. The Indian subsidiaries of multinationals play an important role in the development of India's software capabilities, because they are more willing to undertake high value-added activities, such as software product development, within their own subsidiary in India than they are to send the work to an Indian independent firm.

For at least the medium term, India should be able to retain its position of primacy for software offshoring from the English-language world. In the longer term, unless India makes an even greater effort to upgrade its universities and the technical capabilities of its graduates, China may become an important alternative destination.

China's software and services industry does not currently have a major impact on the world economy. The industry is highly fragmented into many small companies, few of which are large enough to take on large projects for developed nations. The hardware industry is well established in China, and in the future it may drive the software industry to a focus on embedded software. Unlike India, where the multinationals are focused mainly on serving the world market, in China multinationals are more focused on positioning themselves to serve the enormous, emerging domestic Chinese market.

Japan has the second largest software and services industry in the world, after the United States; and it is the fastest growing industry in Japan. Japan makes games software and custom software for the world market and packaged software for its domestic market. It imports a significant amount of systems and applications software from the United States; and it calls on China and India to provide custom software.

There are three typical patterns of Japanese offshoring. Most commonly, a Japanese firm will identify a need for custom software, contract with a Japanese IT company to provide the software, and the IT company will in turn contract with a Japanese subsidiary of a Chinese firm to do the programming work. This programming used to be done almost exclusively in Japan, but as the cost of locating Chinese workers in Japan has become expensive, more and more of the programming is being done in China. A second approach that is more recent is for Japanese firms to invest in China to form wholly owned subsidiaries or joint ventures with Chinese firms. A third approach is for multinational corporations to move programming and back-office functions of their Japanese subsidiaries to lower-cost locations, often in China. The Dalian software park in China is growing rapidly as a result of this emerging Japanese business. The amount of offshoring from Japan is still small, but cost pressures are likely to cause it to increase; and since Japan has such a large software industry, the opportunities for offshoring are considerable.

The European Union represents the second largest market in the world for software and IT services, after the United States. There are many differences, however, from country to country, and the European Union cannot be viewed as a unified, homogeneous market. The European software industry and employment patterns are different from those of the United States, with much more software production done in-house and embedded in physical products. This does not prevent offshoring, and certainly many leading European industrial firms are establishing offshore facilities to produce embedded software. Much of this employment is subsumed under R&D and other activities such as application-specific integrated circuit design.

About two-thirds of the work offshored from Europe is offshored by the United Kingdom. Continental European firms continue to lag UK firms in sending software work across their borders. The Germanic and Nordic nations have only recently begun to build offshore software and software service delivery capabilities, but firms with global practices such as SAP, Siemens, and others are moving rapidly to build their offshore capabilities in Eastern Europe, China, and India. The geography of European offshoring will be somewhat different from that of the United States in that Nordic and Germanic firms will use Eastern Europe and Russia in addition to India. Latin (Romance-language-speaking) Europe has been slower to begin offshoring, but now its major firms are sending work to Romania, Francophone Africa (particularly Morocco), and Latin America in addition to India. Despite these geographical differences, there is no reason to believe that the pressures to offshore software-related work will be substantially different than in the Anglophone nations. In part this is because the US-based multinationals with strong global delivery capabilities, such as Accenture, EDS, Hewlett-Packard, and IBM, are present and competitive in all European markets. European firms may continue to experience a lag due to union and government opposition to offshoring, but their cost and delivery pressures are similar to those experienced by US firms.

In Russia, software was a relatively neglected field during the Soviet era, but in the 1990s as the country transitioned to a market economy, many scientists and engineers moved from low-paid government and university positions into entrepreneurial firms and Russian subsidiaries of multinationals; and some of these people entered the software field. So far there are relatively few programmers. Wages are low. Technical skill level is high, but there is little project management experience. Software firms are typically small, not able to take on large international software integration projects. Nevertheless, the high skill level of the Russian research community, a legacy of its Soviet history, has led Intel and a few other multinationals including Boeing, Motorola, Nortel, and Sun to open R&D facilities in Russia.

4. Understanding Offshoring from a Company Perspective

Instead of examining offshoring by country, it is also possible to examine offshoring by the type of company. We will consider five types of firms. The first are large, established software firms headquartered in developed nations that make and sell packaged software. Examples include Adobe, Microsoft, and Oracle. As a general rule, the largest and most successful packaged software firms are headquartered in the United States; the notable exception is SAP in Germany.

Most large packaged software firms have global operations. In many cases, their offshore operations are for localization work for the local domestic market. However, particularly in the case of India, and also to some degree in Russia, the work is for development of their worldwide software packages. Locating in these low-wage countries enables these firms to have access to lower-cost programmers, many of whom are comparable in skill levels to the company's workers in the developed nations. This is not the only benefit. Having operations in other time zones can speed up production by facilitating round-the-clock production.

These opportunities are encouraging major packaged software firms to expand their workforce in India and other lower-cost nations.

Offshoring will have a complicated effect on the packaged software firms. First, it might and likely will put employment pressure on developed nation software firms to decrease employment in the developed nations. On the other hand, the lower cost and faster production could allow the development of new features in old software and could contribute to the creation of new, well-priced software products, which would in turn increase income for these firms and perhaps lead to greater hiring.

Next we consider large, established software firms headquartered in developed nations that are large providers of software services. These companies may also provide packaged software, though not all of them do so. Examples include Accenture, EDS, and IBM. Software service firms have been among the fastest growing firms in the IT sector, and in general they are far larger than the packaged software firms. Firms coming from the software side (e.g., Hewlett Packard or IBM) and from the service side (e.g., Accenture) are converging. In the case of IBM, this has been through both direct hiring and its recent acquisition of the Indian service firm Daksh (with its approximately 6,000 employees). Hewlett Packard has built its global non-IT services to over 4,000 persons in the last three years, largely through in-house hiring.

Software services is in most respects a headcount and labor-cost business; these companies grow their revenues by hiring more persons. The multinational software services firms have been experiencing increasing pressure on costs due to competition from developing nation producers, particularly from the Indian service giants such as Infosys, TCS, and Wipro. This has forced the multinationals themselves to secure lower-cost offshore labor. Service firms such as Accenture, ACS, EDS, IBM, and Siemens Business Services operate globally, but only in the last five years have they found it necessary to have major operations in developing nations to decrease their labor costs. Today, the larger service firms, including Accenture and IBM, are rapidly increasing their headcount in a number of developing nations, particularly India. At the same time, these firms are holding steady on their developed nation headcount or gradually drawing it down. Given the ferocious competition in software services, there is little possibility that prices will increase substantially. This suggests that, for the large multinationals, the offshoring of services will continue to increase in both absolute numbers and percentages of their global workforce.

Next we consider firms headquartered in developed nations that have software operations but are not part of the software industry sector. This is the enormous and eclectic group of companies that provide all the non-IT goods and services in the economy. Software is now at the heart of value creation in nearly every firm, from financial firms such as Citibank, to manufacturing firms such as General Motors. Customizing, maintaining, and updating IT systems has become an increasingly significant expenditure for businesses in developed countries, and thus firms are actively trying to lower these cost. One way to lower them is to offshore the work to nations with lower labor costs.

It is difficult to estimate the amount of software work that is offshored by these companies. Businesses often do not break out this particular kind of expense, and if work is transferred to an overseas subsidiary, this is considered an internal transfer and may not be reported at all. However, it is clear who does the work. If it is not an overseas subsidiary of the company, then it is likely to be one of two other kinds of firms that provides the service: a large service firm from a developed nation (e.g., Accenture, CapGemini, IBM, and Siemens Business Services) or a firm from a developing nation (e.g. Infosys or TCS in India, Luxoft in Russia, or Softech in Mexico).

It is not certain whether offshoring will lead to a decline in the number of software service employees employed in the developed nations. In the current economic recovery, existing firm headcount throughout the IT sector in the United States appears to be stagnant. In other sectors, limited data are available. For example, in financial services it is unknown as to whether the increasing headcount in developing nations has had any impact on employment in the developed nations. The most that can be said is that non-IT firms are increasing their IT employment in developing nations to serve the global market, and this trend is underway across many different firms, including industrial firms such as General Electric and General Motors.

Next we consider software-intensive small firms, particularly startups, based in developed nations. For small startups, offshoring is often a difficult decision, although more recently a number of firms in the United States have been established with the express purpose of leveraging lower cost offshore skilled engineers. For many smaller firms, an offshore facility can be demanding on management time. This is especially true in India because hiring and retaining highly skilled individuals is difficult. The protection of intellectual property, which is typically the most important asset that a technology startup has, is problematic in India and especially China. There is substantial anecdotal evidence that, despite these challenges, under the pressure from their venture capital backers and the need to conserve funds, small startups are establishing subsidiaries abroad, particularly in India, to lower the cost and increase the speed of software development.

A pattern is emerging for US startups. They may initially use outsourcing to, say, an Indian firm as a strategy, but many soon establish a subsidiary in place of the Indian firm. They do this for a variety of reasons, including worries about intellectual property protection, control of the labor force, and management efficiency. The minimum size of an offshored operation is reportedly as few as 10 persons. If this report is accurate, then it may be possible for many more small firms to establish subsidiaries in developing nations than have done this so far. Unfortunately, data on the scale and scope of offshoring by startups are unavailable.

It is tempting to view offshoring by startups (whether to an Indian firm, say, or to their own overseas subsidiary) as an unmitigated loss of jobs for US workers. Nevertheless, the real situation is more complicated. Lowering the cost of undertaking a startup could mean that the barriers to entry are lowered, thus encouraging greater entrepreneurship. The jobs created by this entrepreneurship should be counted against those lost by offshoring. So, correctly estimating employment net effect of offshoring in the case of startups is very difficult.

Finally, we consider firms in developing nations providing software services to firms in the developed nations. The availability of capable software programmers in developing nations provided an opportunity for entrepreneurs and existing firms to offer programming services on the global market. It was in India where this practice first began in a significant way. Because telecommunications links were not so sophisticated, the Indian programmers initially were placed in the US customer’s premises. This practice was profitable and gradually expanded to include remote provision of services – often to do Y2K work—when telecommunication improved and demand heated up in the late 1990s. These developments created an environment within which major corporations were willing to experiment with overseas vendors, and a sufficient number of these experiments were satisfactory. The result was that offshore vendors, particularly Indian firms, were validated as candidates for software-related projects. These projects also allowed offshore vendors, again particularly Indian firms, to grow in headcount, experience, and financial resources, so that they could undertake larger and more complicated projects.

Software services firms from a number of the developing nations have become players in the global economy. The large Indian firms (HCL, Infosys, Satyam, TCS, and Wipro) are at present the global leaders. However, in China, Mexico, and Russia there are growing software service firms that employ between 1,000 and 5,000 people. Currently, the firms from other nations are not large enough to compete with either the multinationals headquartered in developed nations or the large Indian firms. Medium-sized firms in other geographies can, however, reduce the risk for customers of having all their offshore work done in one country, where it might be interrupted by a natural disaster or by political or military problems. The larger multinationals and Indian firms are also establishing facilities in other geographies, particularly Eastern Europe and, more recently, Mexico.

Firms are leading a global restructuring of the geography of software and software services production. They are experimenting with a variety of strategies meant to utilize workers that have become available in the global economy. This is true of software product firms as well as multinational and developing-nation software service providers. The impact of firms outside the IT sector with large internal software operations transferring some of the software operations to lower-cost environments has been less remarked upon; however, should the current trend continue, this will have a substantial effect on IT employment. These firms have already relocated a significant amount of work from high-cost to lower-cost environments, and this process appears likely to continue, and possibly accelerate, as firms become more comfortable working in developing nations. The offshoring of startup employment bears particular observation because the US high-technology economy in particular is dependent upon the employment growth that small startups provide.

5. The Globalization of Research

IT research is concentrated in only a few countries. About a third of computer science papers come from the United States alone. A few additional traditional centers of concentration of IT research (Australia, Canada, France, Germany, Israel, Italy, the Netherlands, Sweden, Switzerland, and the United Kingdom) account for about another third.

This is not surprising considering the large part of world Gross Domestic Product (GDP) concentrated in these same countries. There is a correlation between Purchasing Power Parity (PPP) Adjusted Gross Domestic Product and computer science publication. However, the share of computer science paper production by scientists in the traditional centers of concentration of IT research is more than 60% greater than their share of world PPP GDP (65% vs 40%). In contrast, Brazil, China, India, Indonesia, Mexico, and Russia together account for 27% of world PPP GDP, but only 7% of computer science paper production.

IT research was even more concentrated in the past than it is today. The initial bloom of IT research occurred in a few select locations in the United States and a few other countries in the aftermath of the Second World War. This concentration has been perpetuated by the natural tendency of strength to build on strength. Particularly in the United States, this bloom was driven by ample government funding and a significant migration of scientific talent from the rest of the world. In fact, there is little doubt that government funding has played an important role in most countries. For example, on a *per capita* basis government funding is significantly larger in Sweden and Israel than in the United States. The pattern of strength in only few countries is amplified by a general migration of scientists from countries that do not support graduate education and research to countries that do.

Research-driven innovation is seen by many countries as a way to increase national wealth and standard of living. Both developed and developing countries are attempting to build up or shore up their research capabilities. This means greater competition among nations in the research area, and in particular competition for talent. Until recently, the United States had won the research talent competition, but that situation is changing. Due to strong efforts to foster research on the part of a number of national and local governments outside the traditional centers of research, IT research is slowly but steadily, and almost certainly inevitably, becoming more global. This globalization of IT research has been accompanied by a significant increase in the production of PhDs outside the traditional centers of concentration, and a reduction in the migration of researchers to these centers. In the long run, there is no obvious reason why IT research should be any more concentrated than world economic activity in general.

Globalization allows more and better people to participate in IT research. Increasing educational opportunities around the world means that more people are able to realize their research potential, thereby increasing the size of the IT researcher pool and the quality of the best researchers. A freer worldwide market in research means that potential funding for IT research can more easily be targeted to those that can most effectively and efficiently create research results. Both of these trends increase the amount of scientific advance that can be obtained from a given level of resources. There is little doubt that this is good for the field of IT and for the world as a whole; however, while we gain as a group, localities and individuals may end up suffering losses.

Globalization provides improved opportunities for people who live outside the traditional centers of concentration of IT research. It also provides improved opportunities for the best researchers, due to increased global competition for their services. It may, however, limit opportunities for other researchers in the traditional centers of concentration, for whom global competition may mean declining wages or even the loss of jobs.

6. Risks and Exposures

Businesses that make offshoring and outsourcing decisions increase their own exposures to risk, and at the same time potentially create additional risks and exposures at many other levels, all the way from individuals to nation-states. Many of these other communities of interest have scant awareness that they are being exposed. For every risk of privacy invasion into an employee database that an employer might fear, data about ordinary citizens is exposed to tens of risks. Bank records, transaction records, call center traffic, and service centers are all offshored today. Voluminous medical records are being transferred offshore, read by clinicians elsewhere, stored and manipulated in foreign repositories, and managed under much less restrictive laws about privacy and security than in most developed countries. The higher exposure to terrorist incursion, sabotage, or extortion attempts has not received wide discussion by companies employing offshore labor.

A basic principle of security is that the longer the supply chain and lines of communication, the more opportunity there is to attack them. The inherent difficulties in international data communications are compounded by jurisdictional issues regarding regulation and legal responsibility. Offshoring risks include data communications vulnerabilities, loss of control of business processes, loss of control over network perimeters, increased network complexity, clashing security policies and procedures, gaps in personnel security, and drastically diminished ability to know about and respond to security breaches.

What seems particularly lacking within many procuring companies is an overall line of authority and responsibility for primary data records as they pass through one, two, or more subsequent offshore companies that perform work on the data set or perform operational tasks for one purpose or another. Such *"hands-off"* management responsibility cannot be presumed to work in the best interests of anyone concerned with risk attenuation.

Risks turn into incidents through two basic kinds of action—accidents and intentional acts. The vast majority of incidents that can be anticipated originate with threat actors: rogue employees, hackers, criminals, organized crime syndicates, industrial espionage, unfriendly nation-states, and terrorists. Effective risk management strategies include security due diligence, business due diligence, active risk management, and third party auditing.

Commercial risk from offshoring is multi-faceted and different from security risk. Business issues are primarily operational—concerning productivity, efficiency, and quality. Business managers everywhere struggle with costs, delivery times, and product quality. Geographic and cultural spread can adversely affect the latter two even as costs seem to be reduced. Communication paths become longer and more convoluted; they are more apt to suffer distortion and error from language and cultural difference. Supply chain networks become more diverse, less centralized, and hence less controlled. Protection from manufacturing sabotage and theft becomes more difficult because of the breadth of the system. Intellectual property protection becomes more porous as the infrastructure expands on an international scale. Legal barriers and costs increase as companies cross international boundaries, due to conflicting regulations, procedures, and practices. Safety issues are exacerbated by decentralized operational logistics.

The most contentious and perhaps most challenging aspect of offshoring is its risk impact on individuals. Individuals are often pawns in this global restructuring of business. They are at risk of loss of privacy, loss of jobs, loss of property through identity theft and credit card fraud, and loss of security. Moreover, they have little say in these business decisions and little they can do to protect themselves.

Offshoring adds threats and vulnerabilities that do not exist in domestic outsourcing, and increases vulnerabilities that exist in all inter-network commerce. Multiple legal jurisdictions add new risks. Distance adds complexity and vulnerability because cyber-space is actually a complex of real-world service providers in distinct jurisdictions with varying cultures, all under cost pressures. A company acting under a business culture not easily known to clients cannot be assumed to be exercising all the same precautions that might be common practice in the client business's country. As more and more countries provide offshore services, the price pressures on providers of outsourced services increase. With increased price pressures, the temptation to skimp on security measures gets stronger.

There are a number of steps that can be taken for protection. Data that is being transmitted should be encrypted. Offshoring providers should be vetted carefully. Companies should have security and data privacy plans and be certified to meet certain standards. Service providers should not outsource work without the explicit approval of the client. Mass export of databases should not be permitted. Data should be accessed one record at a time and on a need-to-access basis. The database should be encrypted. Certain types of data should not be allowed to be exported across national boundaries.

Offshoring can also place national security at risk by threatening both military and critical infrastructure operations. For example, the United States and other countries' IT-based military systems have adopted COTS (Commercial Off-The-Shelf) product purchasing strategies, shared national and international commercial infrastructures, and Internet Protocol technologies to facilitate network-centric warfare systems. It is more difficult for the buyer to gain insight into source and application code documentation for COTS products, especially if the providing companies are offshore. Many COTS components and sometimes whole systems are developed and maintained by providing companies, which may themselves procure development and services from other nations with privacy, intellectual property rights, security, diplomatic, and defense policies possibly at odds with the original procuring country. Thus, a COTS strategy increases the possibility of a hostile nation or non-government hostile agents (terrorist/criminal) being able to compromise the system or services. Attacks can cause malfunction and destruction of critical infrastructure such as transportation, power, and financial systems, and loss of citizen confidence in their infrastructure and government.

The offshoring of homeland security technology development and management systems that send vital information such as biometrics, identification codes, tax and personal information overseas are of critical concern. Until better controls of this information are developed, this presents a risk to all nations. Further research in methods to secure this data and the development of nation-to-nation and international treatment of both the data and how compromises will be handled is vital.

Globalization is here to stay and so are its international effects. National security and social effects can never be completely mitigated, but country-specific and international strategies can be put in place. Problems cannot be solved until they are defined and accepted as valid by a sovereign entity and its citizens. Topics needing national attention include legislation, international agreements, policing, tariffs, Internet policies, and more equitable tax-structure strategies for companies investing at home. Other topics needing public attention include more formal government-commercial agreements and funded research to address data protection and communications between stakeholders involved in homeland defense and critical infrastructure.

7. Education in Light of Offshoring

Offshoring creates major changes in the demand for workers. Some countries need more workers, others fewer. Offshoring also causes the set of skills and knowledge of workers to change. Education is a tool that enables a country to provide the skilled workers that it needs, and thus it can be the centerpiece of a national policy on offshoring. Developing countries that are building up their software service export markets, such as India and China, need to prepare growing numbers of people to work in this industry. The developed countries are facing questions about how to revise their educational systems to prepare their citizens for the jobs that will remain when other jobs have moved to lower-wage countries. These developed countries also have to find ways of making their education system serve to increase the technological innovation that has historically driven productivity gains, new employment, and new wealth for nations.

The United States has a well-established and complex IT educational system. The bachelor’s degree is the primary degree for people entering a computing career. While degree programs appear under many names, five majors cover most of the programs: computer science, computer engineering, software engineering, information systems, and information technology. Although there are some differences among these five types of programs, they are many similarities in providing foundational knowledge related to computer programming, the possibilities and limitations of computers, how computers and computing work in certain real world applications, various skills about communication and teamwork, and other topics.

In addition to the five traditional kinds of departments, a variety of new academic units related to computing and information technology have begun to emerge in US universities. These include schools and colleges of computing that typically include the degree programs in computer science as one component, new schools that are separate from computer science and information science programs that fill an additional need in the computing and information technology space, information schools that in almost all cases evolved from library schools, and campus-wide multidisciplinary information technology institutes aimed at fostering collaboration of faculty and students across departments. While they are not the programs intended to produce ace programmers or deep technical experts, the mix of skills and perspectives is a reasonable educational experiment to try to produce students well suited for higher-value-added jobs. There is also rapid growth in degree programs offered by for-profit universities, which provide a convenient entry to the profession for working adults.

Non-degree programs also play an important role in US IT education. They include certificate programs, non-degree courses offered by traditional colleges and for-profit organizations, training associated with specific technologies, and corporate training programs. These alternative kinds of training programs appear to be growing rapidly, but it is difficult to quantify their extent or growth. There are many different goals being sought through enrollment in these non-traditional programs: training for a specific IT career, career advancement within the IT field, move from a non-professional to professional IT job, continuing education to keep technical skills current, or gaining specific product information or usage skills. There is also training provided by corporate universities for employees, customers, and suppliers, which might include technical training, background information about the company or its industry, or core competencies such as learning skills, communication and collaboration, creative thinking and problem solving, global leadership, or career self-management.

Recent changes in Europe, under the Bologna Declaration, have the goal of unifying the European educational system along the lines of American system of separate bachelor and master degrees. The Bologna process provides a standardized sequencing of degree programs, makes it less time consuming to obtain the first undergraduate degree, and makes the system more open for students who received their baccalaureate degrees in developing nations to enter masters programs without having to repeat some of their earlier training. The Bologna initiative has stimulated new interdisciplinary and specialized studies in computing within European universities, especially those incorporating domain-specific knowledge such as bioinformatics and media-informatics, and has also created separate programs in software engineering and telecommunications. The increasing uniformity of IT education across Europe will provide additional incentive for offshoring work from higher to lower wage countries within Europe; in the long run it may lead to a leveling of IT wages across Europe.

The German model is particularly important since the German-speaking nations represent approximately a quarter of the European population. There are some major voices in Germany in opposition to the Bologna initiative. For example, the T9 initiative, by the nine largest and leading technical universities in Germany, argues that the traditional model of university education leading to a diploma after nine semesters has considerable advantages over the system that leads to separate bachelor's and master's degree. It is unclear whether this will lead to modifications in the Bologna model over time.

India, as the largest supplier of exported software services, faces a different set of educational challenges from the United States or Europe, namely to ramp up its higher education system to staff its rapidly expanding software industry. Soon after India achieved its independence in 1947, a decision was made to invest a greater amount in higher education than is typical for a developing nation, even though there was not enough money to finance primary education for all. This decision was taken in part to support the efforts to build an educated workforce for the heavy industry that India's leaders envisioned would provide an important part of its revenue base. The investment in higher education was advantageous to India when it opened up its markets and began to participate more extensively in global trade in the early 1990s. There have been many competing claims on government funds, and the central government has not been able to keep up with the increasing demand for higher education. Policies were liberalized in the early 1990s, allowing the formation of new private institutions of higher learning, resulting in the rapid development of private postsecondary education. Whereas only 15% of engineering seats in university had been at private institutions in 1960, 86% are private today. The rapid advancement of the private university system has created some problems. Quality varies widely, from clearly substandard to the highest international quality, and the government has not established, much less enforced quality standards. Some Indians also object to the high tuition and fees as being counter to the equal access goals of the nation.

Today the higher education system in India is extensive and rapidly expanding. It currently includes more than 300 universities, 15,000 colleges, and 5,000 training institutions. Nevertheless, only 6% of the college-age (18-23 year old) population is enrolled in college or university. Some of the schools, such as the Indian Institutes of Technology and the Indian Institutes of Management are world-class; but the quality falls off rapidly after the top 15 schools. Total bachelor and master degree production in the computing and electronics fields is approximately 75,000 per year. There are also some 350,000 students in other science and engineering fields at universities and polytechnics receiving degrees each year, and many of them enter the IT industry upon graduation.

Training in the latest technology, English-language skills, and other work-oriented topics are also important to the Indian software industry. This training is offered both by many independent training organizations and some of the large IT companies such as Infosys and Wipro, which run their own training operations.

China faces the same educational issue as India in building a trained workforce for its software industry, but its approach is different, through centralized planning. When the Communist Party came to power, it was committed ideologically to education and the use of science and technology for economic development. Upon the establishment of the People's Republic of China in 1949, the Western powers pursued a policy of isolating China; a by-product of this was China's adoption of the Soviet Union's model of comprehensive and specialized universities and a large network of research institutes. In 1978, the Chinese university model was reformed to one that more resembled that of the United States and emphasized comprehensive universities. In the 1980s, China began sending many of its brightest science and engineering students to the West, especially to the United States, for graduate education. Nevertheless, the government research institutes within China are still enormous and play an important role in graduate education. Until recently, only a very few universities undertook research; their highest priority was pedagogy.

As in the case of India, Chinese universities graduate an enormous number of students every year. In 2001, 567,000 students received their first degree, including 219,000 in engineering and 120,000 in science. The quality of these graduates varies dramatically, but the sheer volume means that China has a large reservoir of technically trained individuals.

Until 2001, Chinese universities neglected software studies as an academic discipline. At the end of the 1990s, the Chinese government recognized that it had a shortage of trained software personnel and called for improvement in Chinese software capabilities as part of its central planning efforts. In response, 51 Chinese universities established masters degrees in software engineering. These degree programs quickly attracted students. Including all the different kinds of curricula, China is now training about 100,000 people per year for the software industry. There are internal criticisms of the education, including overemphasis on theoretical education, insufficient attention to practice, and lack of familiarity with international standards.

There are many challenges to implementing an educational response to offshoring. Consider the challenges in the United States. IT work encompasses many different occupations, each with its own skill and knowledge requirements. There are five major types of undergraduate degree programs in IT, and each would require revision in order to address offshoring. There are similarly four different degree levels (associate, bachelors, masters, and doctorate) to revise. Non-degree programs, such as certificate programs, corporate training, and non-traditional universities all also play an important role in preparing the IT workforce. There are multiple career paths in IT to take into consideration, not just the traditional one from a college degree to a career in the same field. Universities are slow to make changes in their employees and their course offerings. It is hard for national bodies to predict and match supply and demand for the IT workforce, so it is hard for the higher education system to know how to set its production levels. The mission of a university is not only to prepare tomorrow's workers; there are other goals such as research, preparing tomorrow's teachers, giving students a liberal education, and teaching them to think critically that must be considered when revising a university's program to address workforce needs. Offshoring itself is rapidly changing (from bodyshopping, to call centers, to business process outsourcing, to knowledge process outsourcing and other higher value added tasks), so how is a higher education system to know what occupations to prepare its students for? These challenges mean that educational systems will have to continually adapt to serve well their students and countries in the face of increased globalization.

Although the educational needs and issues may look different from different national or individual perspectives, this study has identified six overarching principles that should apply in developing as well as developed countries wishing to participate in the global software industry.

There is a need to consider the levels of IT work that are predominant in the national or multinational economy being served by the educational institution, and which are likely to be predominant in the coming years. Software and IT work can be thought of as consisting of a spectrum from the more routine (e.g. system and computer maintenance and support, basic programming) through the more advanced (e.g. application programming that requires knowledge of IT and specific applications, whether business, science, media or otherwise, or sophisticated systems programming and IT architecture development) to the advanced strategic (development of approaches that utilize IT to advance the organization strategically and provide it with a competitive advantage). As computer science and IT curricula are developed, particularly at the national level, it is important to consider the levels of workforce preparation to which the curriculum is addressed. In nations that are current recipients of offshored work consisting of programming and routine software testing and maintenance, for example, it may be desirable to focus the curriculum more heavily on the lower levels. This may change, however, as the roles played by IT professionals in these countries evolve and the offshoring providers aim to perform higher level work. In countries that are seeing their commodity IT work being offshored, it will be desirable for the curriculum to prepare students for the middle and upper levels of IT work, where the ability to merge computer science and IT with applications and strategy are important. This is likely to lead to an increased emphasis on application knowledge and a reduced emphasis on programming skills. It should be stressed that in all cases, however, the predominance of a certain level of IT work in a certain nation or region is just a generalization; all levels will exist in all countries, and students will be needed to move into all of these levels. It is the distribution that will vary.

There is a need for CS education to evolve, whether due to globalization or not. The skills and talents needed by software and IT professionals have evolved over the past half century, independent of issues such as outsourcing and offshoring. In general, IT professionals are more likely to work in an application-specific context than previously, and conversely, less likely to work on computer-specific areas such as compiler or operating system development. They are more likely to work on large software applications in teams that include applications specialists, and depending on the organization, also to collaborate with sales and marketing staff. They are also more likely to work in an environment where they are expected to be masters of certain software platforms and interoperability standards, and know how to reuse code. Thus in general, it will be increasingly important that a computer science or IT education involves training that enables the student to work on large-scale software applications, to understand important business, scientific, or other application areas, and be familiar with the tools and platforms that are increasingly the standards in the international marketplace. It also is increasingly important that the education emphasizes teamwork and communication skills, especially as they are practiced in a geographically distributed fashion.

There is a need for education to begin to prepare students for a global economy and its possible impacts on their careers. It is increasingly likely that an IT professional will be working in a global context. This may include being part of a multinational team, or collaborating with customers or suppliers from other parts of the world. Thus, it will be increasingly important that an education in computer science and IT help prepare students for this global workplace. Education that acquaints students with different languages and cultures, whether through courses, study abroad, or other means, will be increasingly beneficial. Finally, to the extent that English is the common language of the IT industry, the ability of nations to educate their IT professionals to be fluent in English will be a major factor in determining their success in the outsourcing economy and in multinational endeavors.

Educational systems that help prepare students to be creative and innovative will create advantages for those students and their countries. As the lower tiers of software and IT work become more commoditized, creativity and innovation will become even more important, particularly in countries that experience the loss of support and programming work. The creation of new products and new businesses will continue to lead to the greatest commercial and scientific successes, and even more, become the differentiator between organizations and between nations. Historically, some educational systems are seen as fostering creativity in students more successfully than others. One crucial differentiator in fostering a creative mentality in students is the research component of the educational system, and the participation of students at all educational levels in the university's research enterprise. Another differentiator is the degree of rote learning versus more open problem solving. Nations that currently have an advanced research enterprise in their university systems may increasingly see this as their greatest competitive advantage in educating computer science and IT students for the higher tiers of the IT workforce. Nations that do not include a research component in their university systems will need to consider whether, strategically, the investment in developing this component and culture is needed to attain their goals for the IT economies in their countries.

Educational systems that not only pay attention to current business and industry needs but also provide a core foundational knowledge will create advantages for those students and their countries. To cite two national examples, the Indian educational system has been particularly good at teaching the latest technology that is needed in business and industry today. The United States has been particularly good at teaching foundational knowledge that is likely to serve a student through most of his or her career. Foundational skills help students remain current, and not become obsolescent, as the technology changes rapidly around them. Although the particulars of a new technology in the workplace may be different from what a student was taught in school, a basic understanding of computing principles and ways of addressing problems will remain current even as the particular technologies change. Of course there needs to be a balance between fundamentals and currently relevant technologies in the student's education. In order to prepare students to be productive workers when they enter the job market, it also is important that the educational system pay attention to the current needs of business and industry and select the technologies it exposes students to in order to address industry needs. This goal can be achieved through respectful interchange between people in the academic and industrial/business worlds. No IT education can possibly fulfill all of the student's educational needs for an IT career, however, and IT workers should expect to have to engage in life-long learning in order to keep up with the rapid pace of technological change and the rapid changes in the way that organizations employ information technology.

A good educational system requires the right technology, a good curriculum, and good teachers. Fortunately, personal computers are relatively inexpensive, software for them has been commoditized, and fast, inexpensive broadband communication is readily available most places in the world. Thus, the technology for training an IT workforce is within reach of much of the world. The model curricula that have been designed by the professional societies have been and should be used in many places around the world. There is probably value in developing a process by which these curricula can have greater business and industrial input and react more rapidly to changes in the way that IT gets used in the world. Although adopted around the world, the model curricula have been designed primarily for degree programs in the United States. If the professional societies truly aspire to be world bodies and develop world curricula, they should pay attention to the needs of other countries and their degree programs as well. The teacher problem may be the most difficult one to address. For example, in the United States, there are serious problems with the preparation of high school teachers who introduce students to IT, and several times in the past (in the late 1970s and again during the dot-com boom of the late 1990s) American universities had difficulty recruiting and retaining quality faculty because of the lure of industrial IT positions, and had inadequate number of students obtaining doctorates, which are required to become faculty members. In India, critics complain about the general quality of IT faculty, salaries are low, and there have been no funds to enable research either by the faculty members or their students. Inducements to improve the quality of the faculty would be helpful in India, the United States, and other countries.

8. The Politics of Offshoring

Globalization, especially in its manifestation as offshoring, is a hugely disruptive force that effects the national movement of wealth and jobs. In addition to the educational responses to offshoring discussed above, countries might adopt political responses. Developed nations might take political action to stem the loss of jobs and wealth to globalization, either through protectionism or measures to make the country more competitive. Developing nations might take political action to create an environment in which its software export industry can flourish. Our initial focus here is on the United States, which is largest global offshoring procurer.

Public policy debate about offshoring began in the United States as a result of the wide news coverage of the report in November 2002 by Forrester Research that 3.3 million US jobs would be lost by 2015 as a result of offshoring. The most common response to offshoring in the United States has been actions by the executive and legislative branches of the state and federal governments to create protectionist laws and executive decrees to control the movement of work out of the country. Bills have been introduced that limit the citizenship or visa status of workers allowed to do work for US organizations or require that call center operatives working outside the United States inform callers of that fact. There are reasons to question the legality and efficacy of this protectionist legislation. Some legal scholars believe that most proposed state laws and executive orders will be ruled unconstitutional because of the Commerce Clause of the Constitution, which leaves control of international commerce agreements in the hands of the federal rather than the state governments. Legal scholars also believe that proposed federal legislation on offshoring may break existing international agreements. There is also a risk of retaliation by other countries to protectionist American legislation.

A second policy approach has been to propose reforms to the H1-B and L-1 worker visa programs. The purpose of these programs is to help US companies find skilled workers, but critics claim that they are being misused as part of a strategy that enables companies to export jobs, especially to India.

A third approach is to ensure that US tax law provides no incentives to moving jobs overseas. These proposals would normalize tax rules between the United States and other countries so that US-based multinationals will have incentive to repatriate earnings to the United States that they earn in other countries. Tax law is hard to enact; and even if it were enacted, there would still be disparities because of costs of health care, safe workplace legislation, and environmental protection.

A fourth approach has been directed at providing support to Americans who lose their jobs through offshoring. In 1962, the US Congress passed the Trade Adjustment Assistance Act to offer job training and extend the length of time of unemployment benefits to American workers who have lost their job through trade agreements. There has been a political and legal battle over whether the Trade Adjustment Assistance Act does or should apply to software workers. Progressives want to go beyond this act and also require companies to provide three months of notification to workers whose jobs are to be eliminated because of trade, extend the term length of unemployment benefits, provide wage insurance paid for by the companies that offshore work to make up some of the drop in wages typical in the displaced worker's next job, improve retraining and reemployment services, offer temporary health care and mortgage assistance, and allow multi-year income averaging on federal taxes.

A fifth approach is to improve the innovation base. The basic idea is that, although some jobs will undoubtedly be lost to low-wage countries, America can produce a substantial number of new jobs, including many of them that are high on the value chain, through policies that create a climate of innovation. Innovation policy generally has four elements: making it more attractive for foreign students and scientists to work in the United States, improving the educational system in the United States, attracting US citizens to the science and engineering disciplines, and increasing federal support for research and development. There have been numerous criticisms that the United States is not now doing enough to build that innovation base, and there are proposals under discussion by both Democrats and Republicans in Congress, as well as suggestions from various non-profit organizations, to create new innovation initiatives.

How do policy issues in other countries that offshore work compare to those in the United States? Australia presents an interesting case study in the politics of offshoring in that Australia offshores work but is itself a country that has benefited greatly from free trade, both in terms of its important export markets for wheat, wool, coal, wine, education, and tourism, and also for the range of products that are available to its citizens through imports.

Debates over free trade arose in Australia over offshoring in 2004. There was sharp criticism from the opposition Labor Party to the lack of policies protecting Australian jobs and workers. Interestingly, the Australian Computer Society published a policy paper that advocated free trade and resisted any protectionist measures. Instead, it called for improvements in existing government programs to help displaced workers with re-training and re-tooling, check-lists that would educate Australian companies on the cost-benefit analysis of offshoring so that they would not rush headlong into it, and changes in industrial policy to enhance Australian R&D. The sitting Howard government was pleased with the report and outlined its own policy initiatives, which included more government support for displaced workers, an effort to increase foreign direct investment in Australia's IT industry, and various improvements in teacher training, educational programs, and educational assessment.

New Australian government data appeared this year, showing that many of the temporary visas for skilled workers are held by Indians, and many of these visa holders are doing programming work. These numbers concerned the Australian Computer Society, and they have taken harder-line positions on both the skilled temporary visa program (known as "457" visas) and on a permanent residence visa program, known as the General Skilled Migration Program. While still endorsing the basic immigration policy of the Australian government, ACS has called for adjustments in the 457 system to make it fairer. It has also called for the permanent immigration program (General Skilled Migration Program) to be substantially reduced until the market can absorb ICT graduates from Australian universities, Australian computer science enrolments begin to increase, and unemployment levels for computer workers fall to the level of other professions in Australia.

Sweden provides an example of the policy stance of a Western European country that engages in offshoring. The Swedish economy and welfare has benefited greatly from a long tradition of free trade, starting in the late 19th century. The policy includes agreements between employer and worker associations on the basic principles for wage setting and job assurance and a commitment to overall Swedish industrial competitiveness in knowledge-intensive and high-wage industries. This industrial policy caused Sweden to create one of the biggest high-technological industries in the world; and it has among the highest rates of investments in R&D and outputs in terms of scientific publications and patenting. Sweden has also become one of the most internationalized economies in the world, having a high dependence on foreign trade for its Gross Domestic Product. Part of its industrial rationalization is through offshoring to countries with lower production costs.

On several occasions, specific industrial policy measures have been taken by the Swedish government to support industries with low and decreasing international competitiveness. In the 1970s, considerable industrial support was given to the steel, clothing, and marine industries when they faced large-scale failures, but the measures turned out to be futile. As a consequence, Swedish policy has to a large extent returned to the basic policy principles of free trade, so in the current globalization trends Swedish policy is almost completely free from protectionist and direct job-protection arguments. There have, however, been a number of initiatives to improve Swedish competitiveness and counteract the negative impact of offshoring. They are all related to a new national innovation strategy advanced in the spring of 2004, which has three fundamental points: technological development and R&D as the key to Swedish competitiveness, investments in large-scale public-private partnerships to achieve centers of excellence in R&D for specifically targeted industries, and reorganization and increased funding for R&D startups and growth of small and medium-sized research-driven companies. Software is not explicitly mentioned in the plan. In Sweden, software development and production is primarily embedded in other manufacturing or service-providing value chains.

Turning now to the developing countries that export software service work, there have been significant policy issues at the national and state levels that have shaped the climate for the Indian offshoring industry. These include regulatory policy as it affects foreign direct investment, taxation, building an infrastructure, protecting intellectual policy, data protection and privacy, and education and training policy.

The regulatory history is the longest and most comprehensive of all Indian policies affecting offshoring. From the 1950s to the early 1970s, Indian economic policy focused on identifying ways for domestic companies to replace imports. Policies enacted in the 1970s that severely limited foreign ownership in companies operating in India drove out some multinationals, including IBM. Regulation in the 1980s promoted the development of the hardware industry and identified software as a promising export business; however, India had limited success in the 1970s and 1980s in building an indigenous IT industry. India was forced to liberalize its economy in 1991 in the face of severe cash problems. The new industrial policy included reduced licensing requirements in most industries, allowed foreign companies to hold majority interest in Indian companies in many industries, provided for automatic approval for hiring foreign technicians and foreign testing of technologies developed in India, and reduced restrictions on the ways in which mergers and acquisitions could take place.

Tax policy also had a shaping effect on the Indian software industry. In 1981, the Indian tax code was revised to establish tax-free zones on profits and gains for manufacturers, including software manufacturing. In 1993, the law broadened the tax-free zones to include various science and technology parks. The law was again broadened in 2005 to give tax breaks to software firms outside these parks.

Infrastructure policy also shaped India's software industry. Laws intended to build a favorable infrastructure and reduce labor regulations and other bureaucracy for the software industry were enacted primarily by individual state governments, mostly in the southern part of India. The one infrastructure issue subject to federal governance was telecommunications policy. Beginning in 1991, the telecommunications sector experienced a series of deregulations that continued until recently. Deregulation enabled the Indian software industry to have access to a completely modern telecommunications system with a capacity and cost that enabled the offshoring service companies to be internationally competitive.

China provides an interesting contrast to India. China is a policy-driven society, and one sees much more significant intervention of the state in the economic development of the software industry in China than in India. The national software strategy in India has been focused on the export service market, whereas the Chinese are interested in capturing their domestic software product and service markets as well as participating in the export market.

Until the 1980s there were mainly local rather than national companies in China. Much of the capital available to businesses was tied in one way or another to the state, and many of the decisions on capital allocation were made at the local level. Since then, internal trade barriers have been dropped, enabling companies to build scale and move into neighboring markets. In recent years, the national government has promoted economic reform through competition among provinces and growth for individual companies by access to capital through the national stock market. Consolidation and focus on the international market has not yet occurred in the Chinese software industry. As of 2002, there were over 6,000 software firms in China; only 19 of them had sales exceeding $120 million.

Chinese policy towards forming technological capabilities has changed over time. From 1978 to 1985, the focus was on central planning and state control. In the period from 1985 to 1991, the focus was on enhancing the innovation system through greater state support for both public and private R&D. Since 1992, the focus has been on enabling market-oriented reforms to improve the quality of research and the skills of the workforce, and to broaden the focus on development beyond the defense and heavy technology industries.

The government has taken a strong hand is the development of trained personnel for the software industry. This included not only new educational programs, as described above, but also concentration of highly skilled software talent in certain geographic areas, by having the government facilitate transfers of skilled software personnel to the chosen places, including providing accommodation for their spouses and children. The Chinese government has also provided incentives for overseas Chinese software workers, especially managers, to return home through such incentives as cash payments, cars, houses, and promotions.

The Chinese government supports R&D in universities, research institutes, and to some extent industry. The best known of these initiatives is the Ministry of Science and Technology's High Technology R&D Program, known more commonly as the "863 program", which has provided more than a billion dollars of government funding for basic research since 1986. Other programs to provide research support include the Development Fund on Electronic Information Industry, an R&D Fund on Industrial Technology, and a Technological Innovation Fund. Although the government has continued to support important state research institutes, such as the institutes of the Chinese Academy of Sciences, there has been an effort to make them less dependent on the state and encourage them to reach out to obtain external funding sources.

The government has also taken steps to improve the competitive business environment. China does not have a long history of controlling anti-competitive behavior in a technological sphere, and it has thus had to pass a series of acts that protect a competitive environment, making illegal certain kinds of behavior such as impugning another company's reputation, bribing, threatening, and dumping. There have been targeted tax reductions to companies that meet certain sales and export figures. Exporting firms have been given favorable terms on bank loans, export insurance, and taxes and duties.

China has one of the world's worst software piracy problems. The Chinese government has taken a series of steps to try to curb piracy. In addition to the general copyright law, China has passed several laws targeted at fighting organized crime that is manufacturing and distributed copies of pirated software. Government organizations are coordinating anti-piracy campaigns, and are being encouraged to be model citizens themselves by using no pirated software. A registry system has been established, under which owners who register their copyrighted software are given extra protections under the law. However, software piracy remains a big issue.

Politics is one of the ways (together with education, consumer boycotts, and labor action) that nations can respond to offshoring. The general movement has been to avoid protectionist legislation. Australia and Sweden have completely espoused free trade even though they risk some level of unemployment for their IT workers. In recent years, India has moved away from its protectionist and isolationist politics of the 1960s and 1970s. The United States has had a number of protectionist actions suggested, but most of these efforts have not been enacted into law, and today there are calls for policies to enhance its competitiveness rather than to protect its jobs by legal and economic barriers. China is the most protectionist of the countries studied here.

All of these countries understand that they have to make their national laws conform to some degree with global practices if they want to be players in the global marketplace. Thus China, for example, has been willing to revalue its currency despite the short-term gain from keeping it artificially low; India has eased many of its trade barriers; the United States has entered into numerous international trade agreements; and Sweden has conformed to international monetary policies.

All of the countries studied here recognize that there are certain risks of sending software work across national boundaries. These include questions of intellectual property, privacy, and data security. Europe has taken the lead in strong privacy policy, and India has seen the economic value in meeting European and US standards on privacy. China is not so far advanced in managing these risk issues as India is, but there is every reason to believe it will have to do so if it wishes to continue to attract international business. China is struggling with balancing openness of information with political control, and so far it leans in the direction of control rather than individual rights.

For the developed countries that send work offshore, a common political approach is to build new jobs and prosperity through policies that increase innovation. Sweden is increasing government support for research and development, and there are calls for this to be done in the United States. The two countries differ on parts of the innovation platform, however. Sweden currently has an abundance of highly educated workers, so it is not interested in ramping up its educational system. The United States is facing declines in foreign scientists studying and working there, as well as declining numbers of American students studying technical disciplines; so an integral part of the innovation platform for the United States is to improve the education system and attract foreign workers and students (to the degree this is compatible with national security policies).

India and China have a number of similar policies for developing their offshoring industries. Both are interested in ramping up their educational systems to supply an adequate number of skilled workers for their IT companies. Both are concerned about having adequate infrastructures (power, transportation systems, telecommunications) to provide good service to their IT companies. Both have adopted a series of policies intended to attract foreign investment. China has implemented policies to try to produce a reverse Diaspora, so that native-born scientists who have been working primarily in the United States and Europe return home to be part of the senior technical and business leadership in their IT industries; India has achieved this same effect without explicit national policies. India has more experience in developing policies to support the export software market than China, but China is advancing rapidly and has a more centralized government-planning model in place.

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Chapter 1: Offshoring: The Big Picture

"*Offshoring is nothing less than a revolution in the tradability of services.*" (World Investment Report 2004, p. 148)

1. 1 Introduction

In the United States today, there are two views about the offshoring of IT and IT-enabled services. Some people, such as the television business commentator Lou Dobbs, see a crisis in our midst. More than a million blue-collar manufacturing jobs in the United States were lost in the last ten years, mainly to low-wage Asian nations. The solace in all this for American policymakers had been that another kind of job – the high-paying, white-collar jobs in the computer and other knowledge industries that had long been dominated by the United States – seemed immune to competition from low-wage countries. But then the pattern of job loss began to be repeated in the white-collar labor force as the software and IT-enabled service sectors moved jobs to Malaysia, the Philippines, China, and especially India. Dobbs and others called for protectionist measures to stop the hemorrhaging of high-paying jobs from the US economy. They believed that offshoring was not only going to do short-term harm to those who lost their jobs, but also long-term damage to the individuals and communities losing these jobs.

Others disagreed, pointing out that when this work is sent offshore, although domestic labor may lose in the short term, there are many winners in the high-wage country: consumers through lower prices; companies through higher productivity, more competitive pricing, and shorter time to market; shareholders through higher corporate earnings; company executives through higher compensation packages; and perhaps a select group of other employees whose jobs change to include more interesting tasks associated with innovation and exclude much of the drudgery of mundane tasks. Many of the supporters of offshoring believe that the individuals who lose jobs will be able to find other good jobs, especially if they are given a safety net from the state consisting of temporary benefits and retraining, and that the total number of jobs may actually increase over time through higher productivity and greater competitiveness of the companies that send work to low-wage countries.

This difference of opinion in the public debates over offshoring is also found among professional economists. Economists are generally regarded as being in favor of free trade. For example, one economist who has looked closely at the issue of offshoring is Catherine Mann of the Institute for International Economics in Washington, DC. She argues that free trade will eventually lead to greater prosperity for the nation. She points to the case of computer hardware manufacturing where many manufacturing jobs shifted from the United States to East Asia in the 1990s as having been highly beneficial to the American economy. Western innovation, coupled with global sourcing, led to price reductions in products. This led in turn to more IT investment in the Western nations, higher Western productivity growth, and ultimately enhanced growth in gross domestic product. Mann believes the offshoring of computer hardware manufacturing was one of the reasons for the robust economy in the 1990s in the United States and argues that the long-term national economic benefits from outsourcing software and services are likely to be even greater than the benefits from outsourcing hardware manufacturing. On the other hand, both Paul Samuelson of MIT and Ralph Gomory of the Sloan Foundation, working with William Baumol

• W. Aspray and O. Berry took a leadership position in the writing of Chapter 1.

of Princeton University and NYU, have done analyses that show that high-wage countries can lose through trade under certain circumstances. (Mann's argument is discussed later in this chapter, Gomory and Baumol's in Chapter 2.)

Looking at this same issue from the perspective of a low-wage country such as India, you can also see two perspectives. Offshoring work is the top growth area in the Indian economy, and it is the driver of India's international trade. Hundreds of thousands of new jobs are being created, and even entry-level positions in this field pay much more than the average wage. IT is seen as the way for India to leap from being a third-world economy in the 20th century to a world leader in the 21st century. However, this IT workforce still represents only a tiny fraction of the Indian population, and there is a backlash to all of this change in a country with rich cultural traditions. The traditional family structure is threatened as young people move to the high tech centers for work, have large disposal incomes, and otherwise follow work practices that do not fit with traditional culture. This economic growth has brought congestion, unbridled growth, and severe wage differentials to cities such as Bangalore. The benefits of offshoring are unevenly distributed with little benefit for the majority of the people in China or India who are rural, poor, uneducated, and without English language skills. Some critics complain that government funds spent on attracting and building the infrastructure for IT companies could be better spent on helping poor and rural populations with clean drinking water, better primary education, and other basic infrastructure.

Which of these pictures is correct? Is offshoring leading to long-term deterioration of Western living standards or is it the means to greater productivity and prosperity in the West? Is it the economic savior for low-wage countries such as India and China or is it the death knell for another traditional way of life? This chapter will introduce the subject of offshoring of software and services and provide a framework for understanding it and related issues from the perspective of both high-wage and low-wage nations. The following questions are addressed in this chapter; many of them will receive more detailed attention in later chapters.

- What do we mean by outsourcing, offshoring, and globalization of software?
- How did offshoring come about?
- How much work is offshored?
- Which countries send work offshore and which countries do most of this work?
- What types of work are sent off shore?
- Why are firms interested in sending work offshore?
- What are the technical, business, and other drivers and enablers of offshoring?
- Why might a firm, a profession, or a nation not want to offshore work?
- Is IT still a good career choice for people working in countries that ship IT jobs overseas?

1.2 What Do We Mean By Outsourcing, Offshoring, and Globalization of Software?

It is important to be careful about the terminology used in this study. Outsourcing means that a firm sends work to another organization to be done. Most outsourcing done by US firms, for example, is work sent out to other US firms. The client company might have parts made for them or have another company handle the cleaning of their office premises, for example. Offshore refers to where the work is done. It is a term that applies best to the

United States because, even though the United States does outsource work to Canada and Mexico, most of its work is sent over the seas, largely to India, but also to China, Malaysia, the Philippines, and many other places. Germany, for example, sends work across its borders, especially to Eastern Europe, but there is no water – no shore – to cross.

Some of the work that is offshored is sent to entrepreneurial firms established in low-wage countries. Thus a UK firm that sends work to an entrepreneurial firm in India, such as Infosys or Wipro, would be sending the work outside their own company.

At other times, multinationals headquartered in high-wage countries operate subsidiaries in the low-wage countries to work on products and services for their world market. The multinational might do this by contracting for all the services offered by an entrepreneurial firm located in the low-wage country, in which case the entrepreneurial firm is sometimes said to be a captive of the multinational, and the multinational holds great power over the entrepreneurial firm. The multinational might instead buy an entrepreneurial firm in a low-wage country outright, or it might create its own subsidiary there. These subsidiary firms, whatever their organization, represent an increasingly large share of the offshoring of software services.

Multinationals sometimes open facilities in low-wage countries in order to better serve the local market especially since the Indian and Chinese markets are expanding so rapidly, but that situation is not the primary interest of this study. We are more interested in multinationals that open operations in low-wage countries to serve the world market. Offshoring is part of a larger trend toward the globalization of software under which software products and software services are created throughout the world and sold throughout the world. The aspect of globalization that involves moving work from high-wage to low-wage countries is the most important aspect of globalization for this report but, over the coming years, other aspects of globalization are likely to become important to the professional, business, and policy communities.

More precisely, we should differentiate between captive offshoring and outsourced offshoring or offshore outsourcing as it is often called. For compactness of language, we will often use the term offshoring in this report without consideration for whether the work is done by a captive or entrepreneurial firm. Where it matters, we are careful about the distinction.

1.3 How Did Offshoring Come About?

In order to understand offshoring, it is worthwhile to place it in the historical context of globalization and multinational corporations. The import of raw goods and agricultural products from less developed nations and the export of manufactured goods by industrialized nations goes back centuries to a time when transportation across long distances became feasible. Over time, some countries placed tariffs and other protective barriers on international trade to protect their markets or industries. The first period of intensive globalization came in the nineteenth century when laissez faire economic theory drove nations to reduce or remove tariffs that limited the movement of goods. Globalization was also driven by the adoption of the gold standard by many countries in the second half of the nineteenth century. Gold stabilized the value of money and greatly enhanced trade across national borders. Globalization led to the concentration of industrialization in the industrialized countries at the expense of their agricultural bases, specialization in the manufactured products they exported, growth in population, and demand for greater import of agricultural products from agriculturally oriented countries. Globalization led to a substantial increase in wealth for the industrialized countries.

This period of globalization ended with the onset of the First World War, and then an era of protectionism ensued between the two world wars. The second wave of globalization, which continues today, began near the end of the Second World War with a meeting in Bretton Woods, New Hampshire in 1944 that led to the formation of The World Bank, The International Monetary Fund, and the reestablishment of the gold standard. The World Bank, whose original mission was the financial reconstruction of nations destroyed by the Second World War, broadened its mission to include reducing poverty through the funding of state governments to improve their educational, agricultural, and industrial systems. The International Monetary Fund was formed to oversee the global financial system. This it has achieved by making the international monetary system more stable and by helping out countries with monetary problems by supplying them with financial and technical assistance.

The period since the Second World War has been characterized by a series of international agreements to promote free trade. This period began with the General Agreement on Tariffs and Trade (GATT). Twenty-three countries participated in GATT's first round of talks in Geneva in 1948, but by the Uruguay Round of talks in 1993, the number of countries participating had increased to 123. The Uruguay Round of talks led to the formation of the World Trade Organization (WTO) as a successor to GATT. Under the WTO, there have been a number of different approaches to enhancing global free trade: reduction of tariffs, export subsidies, and other trade restrictions; formation of free-trade zones; reductions of restrictions on capital; and increased agreement among national intellectual property laws. Country membership has grown from 26 in 1993 to 148 today. The net effect of all this is to have many more countries participating in international trade and to provide conditions that enable this trade to occur more easily.

Multinational companies, which are simply companies operating in multiple countries, have played an important role in the globalization of trade. The first multinational was The Dutch East Indies Company, formed in 1602. The rise of big business in the second half of the nineteenth century, with its concomitant separation of ownership from management, created many new multinational companies. Some of these nineteenth-century multinationals were technology companies such as I.G. Farben, which started its chemical business in Germany, and General Electric, which started its electric power business in the United States. Within a few years of their founding, both of these companies were operating in many different countries around the world.

The computer industry attracted firms from the business machines, electronics, and defense industries but also included important entrepreneurial start-ups. A number of companies from the computer industries became important multinationals. These include General Electric (formed in 1895 and entered the computer industry in the 1950s), IBM (consolidated in the tabulating business in 1911), Hewlett Packard (formed in 1939 as an instrument maker and entered the computing industry in the 1960s), EDS (formed in 1962 to serve large users of computers), Microsoft (formed in 1975 to provide products in the microcomputer software industry), and Dell (formed in 1984 to provide microcomputer hardware). It is notable but not surprising that these companies all had their origins in the United States. The United States has dominated the computer industry throughout its history. In its hey-day, IBM alone held about 70% of the world market for mainframe computers, for example. The United States also had the market lead in the electronics industry (mainly because of its dominance of the radio and television industries and its later need for components for the computer industry) and the semiconductor industry, which grew as a spin-off from the invention of the transistor at the regulated US monopoly AT&T and was closely coupled in its history with the computer hardware industry.

US dominance in the computer, electronics, and semiconductor industries continued into the 1970s, but then some changes began to occur. Perhaps the most public story was the emergence of Asia as a leader in the manufacture of electronics and semiconductor devices.

In the 1970s and early 1980s, major US electronics products firms began to set up affiliates in Hong Kong, Singapore, and Scotland to use high-quality workers (with wages lower than US workers) to do labor-intensive assembly such as assembling circuit boards or assembling price-sensitive products such as computer peripherals or telephones. At first, the components were built in the United States and shipped to these assembly plants but over time the assemblers began purchasing components from local sources. Eventually, their skill levels increased and they began to provide turnkey services. One specific example is disk drive manufacture which began to migrate from the United States to Asia in the 1980s; today, very little of this manufacturing takes place in the United States.

A similar story occurred in the semiconductor industry. Beginning in the early 1970s, American (and later European) semiconductor companies such as IBM, Philips, AT&T, and Hewlett Packard began to move labor-intensive chip assembly to low-wage countries in East Asia, including Singapore, Hong Kong, Malaysia, and Thailand. These chips were then shipped back to the American or European electronics firms for assembly into final products. During the 1970s, the American semiconductor firms kept semiconductor wafer fabrication, circuit board assembly, and product-level assembly in the United States. But both computer and electronics firms opened or expanded plants in Scotland and Wales to do circuit board and product assembly for the European market in the 1980s. Scotland and Wales were selected for their educated workers, an English-speaking workforce, and government incentives to attract foreign direct investment. It also helped that wages were lower there than in the United States. More recently formed American companies such as Sun Microsystems, Silicon Graphics, and Cisco never vertically integrated their operations but instead always used contract manufacturers such as Solectron and Celestrica and chip fabricators such as Taiwan Semiconductor. These firms were located in the United States, East Asia, and Scotland.

In the 1980s in East Asia, Singapore's labor rates became too high and its companies began to offshore the most labor-intensive work to Malaysia and Indonesia which had lower wage rates. A similar phenomenon occurred in Hong Kong which offshored its labor-intensive work to China. Singapore and Hong Kong retained the work on circuit board assembly that could be automated. They also began to add backward integration services such as component and circuit design, circuit board layout and reconfiguration for better manufacturing, and forward integration services such as testing, final product assembly, packaging, shipping, and repair. With a few exceptions, the East Asian companies providing these value-added services chose not to produce products that competed directly with their American and European customers. By the end of the 1980s, East Asia had the capacity to provide circuit boards and electronics products to the entire world. At the same time, the United States retained and grew its business for higher-value, lower-volume electronics products such as large computers and communications switching equipment. This work was often done under contract to specialized contract manufacturers, such as SCI and Solectron, that were housed in the United States rather than by the large brand-name electronics product companies themselves.

As more and more of this manufacturing work was done in other countries, middle-class jobs were lost in the United States. It is hard to count the exact number of manufacturing jobs created outside the United States to serve the US market or the needs of US-based multinationals, but the number is probably in the range of a million jobs over the past decade. The labor force in the US Midwestern industrial states was especially hard hit. While this caused a public outcry and led politicians to suggest protectionist actions as mentioned earlier, some economists see a silver lining in these developments. For example, Mann argues that a combination of technological innovation in the United States and the increase of global sourcing and markets for hardware (IT, semiconductors, and electronic components and products) led to price declines. These price declines led to greater investment in IT in the United States. This, in turn, caused increasing transformation of the American workplace and an increase in the development of new products either incorporating IT or using IT in its development or manufacture. These developments, she calculates, caused half of the productivity growth in the United States during the 1990s and translated into increased wealth for the United States on the order of $250 billion in the period 1995 to 2000. Mann assumes that there can and will be a similar pattern of growth for the software industry but that the scale might be even greater for software than hardware.

While there has been angst in America over the number of good middle-class manufacturing jobs lost to Asia, there has also been a widespread belief that good jobs in the software industry would always remain in the United States. However, in the late 1990s and even more so in the past several years, there is a dawning recognition and fear that these high-paying software and service jobs will be moved out of the United States as well. Similar concerns are now beginning to be expressed in Western Europe.

A number of IT-enabled services are being offshored today. They range widely and include, for example, reading X-ray images of patients, identifying risk for insurance companies, and processing financial data, as well as testing, building, and maintaining software for customers. Software was the first service sector to be offshored to a significant degree. This is perhaps because it was easy to transport the work data and work products using simple communications equipment (a telephone and a modem) and because there was a significant wage difference for programmers between the United States (or Western Europe) and India (or China). During the late 1990s, software offshoring seems often to have been driven by labor shortages in the United States, especially associated with fixing the Y2K problem and creating new Internet products and services during the dot-com boom. When the dot-com bubble burst, offshoring continued – with cost as a major driver – and began to represent jobs transferred overseas rather than jobs supplementing an insufficient US labor market. The practice of offshoring became a political issue in the United States only after the recovery from the 2001 recession was historically weak in its creation of jobs. European concern about offshoring lagged behind US concern presumably because the United States began to offshore first and has always offshored to a greater extent than Europe.

Firms have outsourced work for centuries, sometimes even to companies that are outside their national borders. The first offshoring in the software and IT services sector began in the early 1980s: US firms sent some credit card processing to the Caribbean and established call centers there. Software centers provided software services to the PC manufacturers in Malaysia at about the same time. However, there was no substantial software offshoring industry until the 1990s. India, Singapore, Ireland, Israel, and Hungary were all early entrants in the offshoring business. Despite some differences in focus from country to country, described in a later section of this chapter, all of these countries benefited from first-mover advantages. Every several years, as a new application area became hot, the offshoring firms in these countries would turn their attention to this application, moving from business downsizing/reengineering, to Enterprise Resource Planning, to Y2K, to Euro conversion, and so on. These offshoring firms coupled this strategy with an effort to move up the value chain through industry sector specialization in order to deepen their expertise and build trusted relations with clients who would eventually turn over progressively higher level and more profitable tasks for them to do.

The story of how offshoring began in the major vendor countries, such as India and China, is told in Chapter 3. These case studies indicate that offshoring has meant several different things. In India, for example, it began with body-shopping, the process of sending trained programmers to work for a few months in another country on the client firm's premises. This was followed by a blended strategy in which some of the work was done on the client's site and some at the vendor's site in India. Then call centers opened. In the past five years, facilities began to be established to carry out IT-enabled business processes such as accounting. More recently, Indian firms have begun to move up the value chain to do IT-enabled knowledge processing such as reading X-rays, conducting patent analyses, and carrying out IT research and advanced development. The players in this story were at first Indian entrepreneurial firms. But later, multinational firms came to play an important role, sometimes through an Indian firm that did contract work for the multinational company, but also through a firm purchased outright or started up by the multinational company.

The globalization of the marketplace is helping to drive offshoring. The Indian and Chinese governments, for example, have taken many steps to ready themselves to participate in the international software market. Software is seen as attractive to low-wage countries as a way to bolster their economies more quickly than the boot-strapping strategies tried in the past by developing nations. In fact, about one-quarter of all offshored shared-service centers for European clients involve interactions with the development agencies of the vendor's country (World Investment Report 2004). These countries have used tax breaks, marketing subsidies, grants, loans, reduced bureaucracy, and other techniques to attract foreign business and foreign capital. China passed the United States in 2002 as the most preferred location for foreign direct investment. Trade policy has been liberalized in these countries, for example, by reducing or eliminating export taxes and licensing (see Chapter 8 for details). These governments have enacted policies to strengthen the public and private education and training sectors (see Chapter 7). Subsidies have been provided for research and development activities in their countries, especially for development work that is likely to have a near-to-midterm payoff in new products or services. Governments are trying harder to protect intellectual property which has been an especially serious concern to Western businesses about China (see Chapter 6). The Indian central and state governments have worked to improve basic infrastructures such as telecommunications, electric power, transportation (both roads and airports), buildings and technology parks, and other amenities such as international-class hotels, but the infrastructure started in a poor state and the government is not efficient in these efforts. Table 1 describes the state of infrastructure in Bangalore, India's leading offshoring location.

Table 1-1: Bangalore's Infrastructure for Conducting Offshoring Work

Electric power is unreliable, so most companies have backup generators.

Roads are congested and in ill repair (an hour to travel the 12 miles from center city to the outskirts where the outsourcing companies have their campuses in Electronics City and Whitefield).

Work has not yet begun on a new international airport.

There is a shortage of rooms in international quality hotels.

No mass transit exists (talking of elevated railway) so most companies hire their own buses to bring employees back and forth to work.

Telecommunications infrastructure is improving rapidly (cell phones, satellite transmission, transoceanic fiber optic cable).

Source: Fannin (2004)

1.4 How Much Work Is Offshored?

The answer to this question is that nobody has very good data on the amount of offshoring worldwide, whether one measures the number of jobs lost or created through offshoring, the number or percentage of companies offshoring work, the number of companies providing IT software services for export, or the monetary value of this work. Chapter 2 provides a detailed analysis of the problems with the data. It also provides a sample of the statistics about the extent and impact of offshoring in the United States, Europe (with separate breakouts for the United Kingdom and Germany), and India. Adding these numbers up gives some sense of the global situation. In Table 2, we provide a sample of the worldwide statistics as already totaled up by others. One can see from the McKinsey (2005) statistics that the actual number of jobs offshored is still a small fraction (less than 15%) of the number that could be offshored. Other statistics in the table make it clear that one type of offshoring –business process services – is growing very rapidly, and that there is room for considerable growth since only 30 percent of the largest 1000 corporations are currently offshoring any work of this type. It is also clear that India is the major provider of these services. We do not have good numbers for the amount of software service work (software maintenance, testing, programming) being done independent of work for call centers or business process outsourcing. Nor can we tell exactly how much of the offshoring work is being done by independent firms and how much by subsidiaries of multinationals, although it is clear that the latter are a large part of the total. The numbers do, however, give a general sense of the scale of offshoring activity worldwide. Additional information about the size of the Indian and Chinese shares of the world offshoring and software markets is given in Chapter 3.

Table 1-2: The Extent of Offshoring Worldwide

Source	Data Reported	Statistic
McKinsey & Co. (2005)	Amount of onshore outsourcing worldwide as of 2001	$227 billion
	Amount of offshore outsourcing worldwide as of 2001	$10 billion
	Amount of captive offshoring worldwide as of 2001	$22 billion
	Number of IT services jobs globally that could be done anywhere in the world as of 2003	2.8 million
	Number of service jobs worldwide that could be done anywhere in the world	160 million
	Number of actual IT service jobs in offshore operations in low-wage countries as of 2003	371,000

Evalueserve (2004)	IT offshore revenue worldwide, April 2003-March 2004	$17 billion (almost half from India, almost one-quarter from Ireland; includes IT products shipped from Ireland)
UN Conference on Trade and Development (2004) (as quoted on TurkishPress.com)	Percentage of world's largest 1000 companies offshoring business process outsourcing	30
	Value growth in offshore business process outsourcing worldwide (projected)	$1.3 billion in 2002 to $24 billion in 2007
Scholl (2003) (as quoted in World Investment Report 2004)	Market value for offshoring of IT services (not including captive production for multinationals)	$1.3 billion
McKinsey & Co. (2003) (as quoted in World Investment Report 2004)	Market value for offshoring of IT services, including captive production for multinationals	$32 billion

1.5 Which Countries Send Work Offshore and Which Countries Do Most of This Work?

Countries that send software and IT-enabled service work offshore are primarily high-wage countries that have advanced service industries. These are also the countries that have the largest amount of IT work. According to Datamonitor (May 2005), the global data processing and outsourced market had a value of $246 billion in 2004 with North America accounting for 43.6%, Europe 29.4%, Asia-Pacific for 17.8%, and the rest of the world 9.1%. The country that started the offshoring trend and that sends the most work offshore is the United States. The United Kingdom, Germany, France, and other Western European countries come next. Although Japan has an advanced economy, it does not offshore as much work as the United States or the Western European countries. In an interesting turn of events, Indian offshore companies have begun to open facilities in China (where wage rates are lower than in India and a huge local market is opening) and Eastern Europe (to take advantage of proximity to the Western European market –nearsourcing). The extent of this phenomenon is limited and recent, and it is not clear whether it is a strategy for Indian firms based primarily on obtaining more contracts or on taking advantage of lower-wage labor.

Which countries do the offshoring work is a more interesting story. There are quite a few countries that have tried to develop this business, and these countries vary considerably in their skill sets, labor costs, cultural fit with the countries seeking to have work done, levels of technical and business expertise, and type of work that they offshore. The four countries that have the most established offshoring industries (accounting for 71% of the market in 2001) in order of market share are Ireland, India, Canada, and Israel (McKinsey & Co. 2003 as quoted in World Investment Report 2004). The public stories make one think that offshoring work is all done in low-wage countries such as India and China. In fact, the majority of offshoring services have historically been provided by developed nations, and Ireland still leads with a 25% share. However, as Arora and Gambardelli (2005) point out, the value added in Indian offshoring is higher than in Ireland because so much of the Irish work involves localizing US software products for the European market. Moreover, the growth rate of the national software export industry is much higher in India than in Ireland so the relative position is changing rapidly. Canada and Ireland do have lower wages than the United States, perhaps 10 to 20 percent lower, but there are not the extreme wage differentials as there are between the United States and India or China. So this is not yet a north-south or developed/undeveloped nation issue although the trend is in that direction (World Investment Report 2004).

An assessment by the consulting firm A.T. Kearney of the most desirable future locations for offshore work placed India at the top of the list, followed by China, Malaysia, the Czech Republic, and Singapore (A.T. Kearney 2004 as quoted in the World Investment Report 2004). The expected rapid growth in offshoring activity occurring in low-wage countries will make the public perception of who does offshore work progressively more accurate. The Kearney report listed Brazil as the leading offshore source in South America; South Africa in Africa; Hungary, Poland and Romania in Central and Eastern Europe; and Canada and New Zealand among developed nations. Ireland, Portugal, Spain, and the United Kingdom were listed as the preferred destinations for offshore work within Western Europe.

Countries doing offshore work fall into four categories as shown in Table 3. First are those countries that take advantage of their large capacity of highly trained/educated workers and low-cost wage scale. One example is China which has established businesses providing offshore work on embedded software and IT-enabled financial services. Another example is Malaysia which is building up business at the lower end of the offshoring market in call centers and IT-enabled back-office business processing services. The principal example is India which is the fastest growing destination for offshore work and is involved in almost every aspect of the industry from call centers to business process outsourcing, to software maintenance and testing, to software research.

The second category consists of countries that have competitive advantage through their language skills to serve a special part of the market. While it is useful in any kind of offshoring work for vendor and client to be able to speak the same language, it is essential that workers in call centers, for example, be able to speak fluently in the language of their customers. Thus China, which has relatively few people who speak English fluently, is unlikely to become a major provider of call centers to the United Kingdom or the United States. The Philippines, Mexico, Costa Rica, Chile, and Morocco have taken advantage of their bilingual skills in English and Spanish to open up call center businesses serving the United States. South Africa is the leading offshoring nation in Africa because of its English-language skills. Some countries from Francophone Africa (Mauritius, Morocco, Senegal, Tunisia, and Madagascar) have recently started to provide call center and telemarketing service to France. India, of course, has been able to build up its call center business in part because of its English-language skills.

The third category consists of countries that take advantage of their geographic proximity to a country that offshores work, so-called nearsourcing. The nearsourcing countries not only are located nearby, making it easier for executives from the client firms to visit the vendors, but there is often a shared language and culture as well. These countries generally do not have extremely low wages, but their wages are typically lower than in the country that is offshoring the work. Canada is a major nearsource destination for the United States, providing many high-end services. Poland, the Czech Republic, Hungary, and increasingly the Ukraine, Belarus, Romania, and Latvia are building nearsourcing businesses to serve Western Europe, especially Germany. In a poll of 500 top European companies in 2003, the German consulting firm Roland Berger found that 50% of European firms were planning to offshore to other parts of Europe and only 37% were planning to offshore to Asia (Gumbel 2004). China is trying to establish a nearsource business for Japan and Korea. (One could call the second category linguistic nearsourcing and this third category geographical nearsourcing. Doing so suggests that there are other kinds of affinities between nations that might make them want to do business with one another such as a common heritage or legal system as exists between the United Kingdom and countries in its former empire.)

The fourth category consists of countries that have special high-end skills. Like the nearsourcing countries, the wage rates might not be as low as in India or China, but they are lower than those in the United States or Western Europe. Israel provides offshoring in the form of research and development for multinational corporations and niche software products and services, especially in the security and anti-virus software markets. Ireland's offshore business is mainly in the area of packaged software and product development; it hosts many multinationals who are building software products and providing IT services for the European market. It also has a number of small Irish-owned companies operating mainly in niche markets. China is beginning to develop high-end skills in the Linux operating system, bioinformatics, and anti-virus software. Australia exports high-end, IT-enabled financial services. India is beginning to develop research and development laboratories for various European and American-based multinational corporations. Also, one should not neglect the United States which exports the highest amount of IT products and services of any nation, mostly to Europe, and mostly in the form of packaged software and consulting services.

Table 1-3: Nations that Do Offshoring Work

Strategy	**Principal Examples**	**Others**
Cost and Capacity	China India	Malaysia
Language Skills	Philippines Mexico Costa Rica India	South Africa Tunisia Morocco Senegal Madagascar Mauritius
Nearsourcing	Canada Poland Czech Republic Hungary Slovakia	Ukraine Belarus Romania Latvia China
Special High-End Skills	Israel Ireland Australia United States	China India Russia

1.6 What Types of Work Are Sent Offshore?

Various kinds of work involving the use of information technology are being offshored. Types that are of primary interest in this study include:

- programming, software testing, and software maintenance,

- IT research and development, and
- high-end jobs such as software architect, product designer, project manager, IT consultant, and business strategist (the extent to which these jobs have been offshored is an open question).

Because the focus of this study is on offshoring of software and services, we are not primarily interested in the following kinds of IT-related work, even though they are frequently offshored:

- physical product manufacturing – semiconductors, computer components, computers,
- business process outsourcing/IT enabled services/knowledge process outsourcing (e.g. insurance claims, medical billing, accounting, bookkeeping, medical transcription, digitization of engineering drawings, desktop publishing, and high-end IT enabled services such as financial analysis for Wall Street and reading of X-rays), and
- call centers and telemarketing.

A detailed list of the various kinds of IT and IT-enabled services that are being offshored can be found in the World Investment Report 2004 (p. 150). These include various types of audiovisual and cultural services, business services, computer-related services, higher education and training services, financial services, health services, Internet-related services, professional services, and animation. Many of these fall outside the principal focus of this study. In Table 4, we identify skill levels required for various kinds of IT and IT-enabled services also taken from the World Investment Report 2004.

Table 1-4: Skills Categorization of Traded IT and IT-Enabled Services

Skill Level	Definition	Examples	Requires	Comments
low	Low entry barriers in terms of skills, scale, technology	Data entry Call centers	general formal education working knowledge of relevant language basic computer skills	few economies of scale little agglomeration
medium	Complex services that require more advanced skills	financial and accounting services standardized programming work routine data analysis back-office services such as ticketing	specialized training required (perhaps in training schools)	may offer economies of scale may have agglomeration effects

high	Most creative and skill-intensive work	R&D Design services Architectural drawings software design Animation Medical testing Technology systems design	Advanced skills at high levels of specialization, often with strong educational institutions	stringent entry requirements involve agglomerated economies with different skills, enterprises, and institutions interacting with each other to share work, stimulate knowledge flows and allow specialized skills to be fully utilized

Based on Box IV.2 in World Investment Report 2004

Jobs that are at the greatest risk of being offshored are also often those most at risk of being automated, in which case labor would be replaced by technology instead of by foreign labor. For example, although it has not happened to an extensive degree yet, software automation tools might help to automate low-end software development.

The situation is far from static. We described earlier how India first offered body-shopping, then software services, only later IT-enabled services, and most recently research and development. There has been a similar change in the pattern of offshoring by firms in high-wage countries. In the 1980s and 1990s, the typical pattern was for an IT manager to hire an outsourcing firm to carry out some task that was not critical to the mission of the client firm. It tended to be an application development that was highly structured, required relatively little interaction and project management from the client, had clear deliverables, well understood bidding procedures, and transparent risk to both the client and vendor. Often the vendor was located near the client. More recently, the pattern has changed. The outsource firm is hired not by the IT manager but by a higher-level executive such as the CFO, CIO, or perhaps even the CEO. The task is more likely to be mission-critical to the client. The applications are wide ranging, but they often include tasks that are less well structured than in previous times; ones that require greater amounts of client contact and project management and where deliverables, costs, and risk are less clear. The vendor is as likely to be located in another country as nearby.

But what are the characteristics of work favorable to performance offshore? John Sargent and Carol Ann Meares of the US Department of Commerce have provided an excellent and detailed answer to this question that is adapted slightly in Table 5.

1.7 Why Are Firms Interested In Sending Work Offshore?

The public perception is that companies in the United States, Western Europe, and Japan send work to India, China, and other low-wage countries principally because of the lower labor cost. There is some truth to this perception. Companies want to maximize their profits, and, in many cases, the lower cost of qualified labor in these countries is the principal reason for making the offshoring decision. Sometimes companies begin offshoring for cost reasons but continue for quality of work reasons. Sometimes something else drives the initial decision to offshore, for example, the lack of enough qualified workers in the

United States during the Y2K era. This section shows that the situation is complex. There are at least nine reasons, low-cost labor among them, why companies send work offshore, and often more than one reason is in effect in a company's decision to offshore. Here is a summary of those reasons. Chapter 4 gives examples of the ways in which particular companies of various types use offshoring as a strategic tool.

Table 1-5: Characteristics of Work Favorable to Performance Offshore Through 2004

- high wage differential with similar occupation/level in destination country
- high labor intensity
- clearly defined requirements, little nuance
- repetitive tasks
- rule-based decision-making and problem solving
- documented or easily transferred content and process knowledge
- discrete, separable; low degree of interaction across different services, applications
- low degree of personal interaction with end users, clients
- stable applications with minimum of "firefighting"
- long projected useful life to amortize offshore set-up costs
- low-to-medium business criticality
- less time-sensitive, longer transition periods
- projects involving simple and standard hardware and software
- digital, Internet-enabled
- low setup barriers
- low-to-medium technical complexity
- not-multidisciplinary
- projects in business areas in which offshoring is a broadly accepted concept
- tightly defined work processes
- stable process

Source: Sargent and Meares (2004). Note: as the Indian companies, for example, move up the value chain, the characteristics of work subject to being offshored may change.

1. *Reduced Costs and Increased Margins.* In the modern, investor-driven, globalized marketplace, there has been a compression of resources, both time and money, that companies, new and old, have with which to make a new business model profitable. One response to this compression has been to reduce costs. Labor costs are a major portion of service and other knowledge-intensive businesses so it is natural to want to reduce these costs. When a new software engineer costs $45,000 annually in the United States and only $5,000 per year in India, even with many additional overhead costs associated with offshoring, most firms anticipate substantial savings in sending work to the Indian software engineer over doing the work in-house in the United States. In this way, the companies can make their new business start-up funds last longer or increase their profit margins. While the focus in the public perception is on the low salaries, costs are also sometimes reduced because the offshore vendor has scale benefits in doing the work. (Another response to this compression, to address the time issue, is given in point 5.)

2. *Access to Skills.* The United States has the strongest postsecondary system in the world. It trains many highly qualified workers from both home and abroad, and it also imports workers who are educated or trained in other countries. But the United States does not

have a monopoly on highly talented, educated, and experienced workers. As China, India, Russia, and Eastern Europe have joined the world market, there is now an excess of educated workers in certain countries such as India, Ireland, Russia, and some Eastern European countries at a time when the US math and science educational system is slowing down its production. In 1999, for example, China graduated three times as many engineers as the United States. In particular, we are seeing strong pools of talent outside of the United States in the IT, telecommunications, engineering, and health care domains.

Thus another reason for companies to send work offshore is the size and quality of the available labor pool. The applicant pools available to the offshoring companies in the leading offshoring countries in many cases have been larger and stronger than the applicant pools available in the United States and Europe. In the late 1990s, many US firms turned to Indian vendors because they had available programmers with the knowledge of legacy systems to make Y2K fixes. Similarly, during the dot-com boom in 1999 and 2000, many US firms turned to offshore vendors to find enough people who knew the Java programming language. There was an abundance of such people in India, for example, not only because of the large labor pool but also because of the tendency of the Indian higher education system to react quickly to the marketplace and teach skills that are in current demand.

To take advantage of this labor pool, many of the best offshoring vendors spend substantial money on the hiring process, going through a lengthy and rigorous screening process to identify employees who have a higher average quality than those available for the client firms to hire directly. NASSCOM, the Indian software and services trade association, has expressed concern recently about the uneven quality of the Indian educational system, contending that while there are still large numbers of graduates, not all of them have the quality education that gives India this competitive edge in offering this access to skills.

3. *Experience.* Companies from the United States and Western Europe sometimes choose to send work offshore because other countries have greater experience in a particular field than they do. This experience can be of four types:

   A. Experience with a particular technology. For example, China already has the largest number of mobile phones in the world and India may be the second in this regard by 2012; these countries have skipped a level by not putting the infrastructure in landlines but investing more in the wireless domain. Hence, it makes good business sense to do R&D on wireless in India, China, and other emerging wireless markets. A similar situation pertains to Linux which is a part of the Chinese government's national technology policy. While India and China are not yet the world leaders in these fields, they have a growing number of scientists and engineers with knowledge of these fields, and the overall level of knowledge in the country is growing rapidly.

   B. Experience with a particular scientific domain. There are, for example, several countries that provide offshore services with strong labor pools in the biomedical disciplines.

   C. Experience with particular management issues. For example, several of these countries have strong experience managing projects that operate multiple shifts per day.

   D. Experience with cultural and marketing issues in emerging countries.

4. *Time Shifting.* Offshoring enables companies to offer multiple-shift services that may not have been offered prior to offshoring. For example, US hospitals are using US-trained Indian physicians to read X-rays in India in time to deliver the results to the US doctors

the next working day. This move can increase patient service at a reasonable cost. Offshoring medical services can also provide rural areas with access to affordable medical services. Some IT companies have several offshore sites, located strategically by time zone, that enable them to provide round-the-clock services such as help desks and network monitoring, while requiring none of their workers to have to work the graveyard shift.

5. *Time To Market.* Some companies offshore work in order to reduce the time to bring a product to market. The types of work offshored for this reason include R&D, production, and other parts of the supply chain. One reason that time to market can be reduced is that companies can take advantage of time shifting. A design team in the United States can work regular business hours and then turn the work over to their team in China, which is just beginning its regular work day, to either continue the design work or do code checking. Then the Chinese team can turn the work over to their Indian colleagues for the next shift who work on it and turn it back to the US team to start the process all over again. Another way to take advantage of offshoring to reduce the time to market is to divide the work into self-contained tasks that can be worked on in parallel in several locations. Yet another strategy for achieving faster time to market is to compartmentalize the work into a set of tasks that require different skill sets and parcel the work out to the teams around the world that would be most effective or productive at doing a particular part of the work. With synchronization points, this modularized work process can be used effectively to create one single larger product developed on a distributed basis in a timely manner.

6. *Market Access.* Companies sometimes find it strategically attractive to have a market presence in countries in which they would like to sell their products. As Balasubramaniyan, general manager at Wipro Technologies, describes this issue: "Offshoring also helps a company be closer to its global customers, thereby providing appropriate offerings to its regional market and ensuring speedier problem resolution. Developers and support personnel in the relevant geographies have a better understanding of customers' needs, regulatory compliances and regional preferences, and can better implement the product or provide the service." (Balasubramaniyan and Guyer 2004).

7. *Ability to Send Overflow Work.* Many small IT companies, especially those in IT services, are usually faced with "feast or famine" situations, that is, during any given period of time, either they do not have enough work or they have too much work. These small companies cannot afford to keep a very large workforce on their payrolls because they cannot afford the payroll in lean times, and therefore they have to work with a minimum workforce. However, this causes problems for the company when it lands a large project that needs to be completed in a short period of time. These companies can benefit by sending work to large offshore providers who can supply very capable professionals with the right domain expertise at the right cost. Larger companies face this same problem. Companies are unlikely to want to hire extra staff for a project that might only have a six-month or one-year duration because of the cost of hiring and the morale problems of having to lay these workers off at the end of the project. The use of offshore workers enables a company to ramp up and down quickly without these problems.

8. *Extending Venture Capital Money.* After the dot-com and the telecom busts in 2001, many startups, especially in the IT, telecom, and biotech areas, have found it difficult to raise venture capital. Those that have been able to raise such funding – as well as those who are working on a "shoestring" fund provided by family and friends – are left with little choice but to make the funding stretch as far as possible. Lower-cost locations such as Israel and India become very attractive for them, and so it is not surprising that by March 31, 2005, more than 170 startups already had established their R&D centers in

India. Often, the venture capital firms themselves are pressuring the companies to use offshoring to keep costs down.

9. *Other Business Reasons.* Using offshore workers can have other business advantages. Given the low cost of labor, a number of the better offshoring vendors have expanded the ranks of their middle managers who have time to mentor and enhance the skills of the lower level employees and identify and implement process improvements that make the work effort more effective. The vendor might have access to tools that are not available to the client either because they are proprietary or because they would be too expensive for the client to buy but not too expensive for the vendor who can use them for many different clients. Clients who are not in the IT business may have more time to focus on their core business and maximize their overall profits if they offshore their IT tasks. Some companies have found that because the offshore vendors are eager to retain their business, there is a stronger focus on continuous business improvements and customer service than if the work had been done in-house. Public sector companies, who may be regulated against large cost overruns and have rigid work rules that make hiring new employees difficult, may find that offshoring provides them with new flexibilities.

1.8 What Are the Technical, Business, and Other Drivers and Enablers of Offshoring?

Offshoring has been made possible by a collection of technological, business, work process, policy, educational, and other changes over the past 15 years. The technological changes are the ones that are most often mentioned in the discussions about the growth of offshoring, but they are by no means the only ones.

(1) *Telecommunications infrastructure.* Since the late 1990s, there has been a dramatic increase in the telecommunications infrastructure. As part of the dot-com boom, various telecommunications carriers competed to increase satellite and optical fiber networks to the point where there was a glut in the market after the dot-com boom ended and prices plummeted. India now has readily available low-cost, high-bandwidth communication and access to all the major telecommunications applications such as email, fax, videoconferencing, and cell phone. Telecommunications capacity between India and the United States grew from practically nothing in 1999 to 11,000 GBS in 2001. The cost of a one-minute telephone call from India to the United States dropped more than 80% within several years after January 2000.

(2) *Changes in information technology.* A number of changes in information technology also changed the opportunities for offshoring. Low-cost computing power became readily available. Software platforms became standardized: IBM and Oracle provided the standard for database management, SAP for supply chain management, PeopleSoft for human resource management, and Siebel for customer relations. Offshoring vendors could invest in the purchase of a small number of standardized software platforms and train their employees in their use rather than having to deal with possibly hundreds of proprietary software systems. Workers could learn standardized skills that were then portable. Training and skill certification became simplified. A similar effect was created by using commoditized, inexpensive applications software packages. Standardization of data formats and networking protocols made it easier to move large data sets from client to vendor. Interoperability standards such as MDA, UML, CWM, CORBA, and OMA were established during the 1990s, making it easier to modularize software.

(3) *Pace of innovation.* The technological changes mentioned in (1) and (2) can be considered enablers. One study (Bartel et al. 2005) discusses technology as a driver of

offshoring. It found that a high level of IT use in an industry is not a predictor of greater outsourcing. However, an increase in the pace of information technology change does increase outsourcing. The explanation is that firms are more willing to gain access to the latest technology through their outsource vendor than by sinking fixed costs into a technology that is likely to change with great rapidity. One would describe the dot-com era as an era of rapid IT change, hence driving companies to outsource.

(4) *The downsized corporation.* Since the 1970s, businesses in the United States began to move away from vertical integration of the corporation, shedding activities that were not regarded as core competencies, through eras of reengineering and downsizing. During the 1980s and 1990s, more and more activities were pared from the list of core competencies and subject to outsourcing. As IT systems became more standardized, they were seen less as core activities. And as corporations focused more on core competencies, there was big growth in outsourcing of functions outside the core.

(5) *Other business drivers.* There have also been some business drivers of offshoring. When rival firms began offshoring, many companies felt that they had to offshore in order to remain competitive. Companies looked for ways to cut expenses to deal with the economic downturn that began in 2000. Venture capitalists began pushing startups to incorporate offshoring into their business plan so that the burn rate on start-up funds was lessened. Several high-profile business leaders, such as Jack Welch from General Electric and Carly Fiorina from Hewlett Packard, became evangelists for offshoring. As experience with offshoring mounted, some of the early mistakes were understood and some of the early problems with bureaucracy and infrastructure were fixed. It became more acceptable and less risky to offshore; offshoring was no longer restricted to the early adopters such as Texas Instruments or General Electric. Business leaders began to recognize the value of reengineering, both in cost savings and improved performance, that was often undertaken when work was transferred from client to vendor.

(6) *Intermediaries.* The offshoring business created new specialty occupations and firms. Some of them did part of their work on the client's site and offshored the rest; some did all the work offshore on their own premises. Some served as brokers, placing the client's work with one or more of a number of offshore firms. Others served as consultants, helping companies to make the decision about whether to offshore, what work to offshore, and how to make contact and close a deal with an appropriate offshoring vendor. These consulting firms and brokers aggressively marketed the advantages – particularly the labor cost advantages – of offshoring. The presence of these specialty firms made it possible for smaller companies to offshore work by helping them with the management of offshored projects in a cost-efficient manner. Another group of firms emerged to provide support services to the offshore vendors: transportation services, catering services, access to specialty knowledge workers, and the like.

(7) *Changes to the work process.* Changes to the work process have enabled offshoring. Certain kinds of knowledge work have been digitized and business processes have been reengineered, making them suitable for offshoring. The value chain has been divided into separable work processes some of which can be routinized and made subject to offshoring even when not all aspects of the process are amenable to offshoring. This kind of fragmentation of labor process is much more easily done with software and services than with manufacturing. There is also more personal acceptance of having old ways of doing business transactions replaced by using the Internet or proprietary networks to acquire services so there is less resistance to service at a distance. All of these reasons add up to the fact that progressively larger amounts of work can be offshored each year.

(8) *Higher education system.* In the past, one of the great advantages of the United States has been its higher education system. However, some of the developing countries

are using higher education as an effective means to create a skilled workforce, and the numbers are impressive in comparison to the United States. Model curricula, established by professional organizations such as the ACM and the IEEE, have been adopted in many different countries, and the computing machinery needed for classroom instruction is inexpensive in these days of personal computing.

In India, for example, national policy since the Second World War has placed a surprising amount of limited resources into developing the post-secondary educational system rather than in supporting the primary or secondary systems. There are 160 universities and 500 institutes today in India offering computing degrees of one kind or another, and the number is growing rapidly. This is not yet as large as the number of colleges and universities awarding computing degrees in the United States where about 200 universities offer IT-related doctoral degrees and about 2000 colleges and universities offer four-year degrees. However, the number of technical degrees awarded in India as opposed to the number of degree-granting institutions tells another story. India is awarding a much higher percentage of its degrees in technical fields than the United States is. Each year, India awards approximately 290,000 engineering degrees which includes 120,000 information technology degrees, while the United States awards a total of approximately 75,000 computing degrees at the bachelor's, master's, and doctoral levels. India has also rapidly built up a set of institutions for training people for jobs in IT skills training and certification. To cite just one example, the offshoring firm Wipro has established Wipro University with 70 full-time instructors. It trains 2500 workers per year in areas directly pertinent to Wipro's offshoring work.

The United States still holds some significant advantages over India in the higher educational system. Although India has a much larger population than the United States, only a small fraction of its population attends college (7% as of 1997). The Indian system is strongest in IT skills training and undergraduate degrees. University research in India is very modest, and India produces only 300 master's degrees and 25 doctorates each year in the computing disciplines, compared to 10,000 master's degrees and 800 doctorates in the United States. For many years, the United States has been considered the place of choice for advanced degrees for people throughout the world, but this seems to be changing. Because of visa tightening and attitudes towards the United States in the post-9/11 era, the number of foreign students applying to graduate school in the United States has plummeted. The United States also has decreasing numbers of domestic students studying IT (or science and engineering subjects more generally).

(9) *Free-market world economy.* The development of a world economy since the Second World War has provided the opportunity for creating a global software market. International agreements such as GATT and increasing national participation in international organizations such as the World Trade Organization, the collapse of communism, and the liberalization of the economies of India and China have all contributed to making the software market global and in making India and China major participants in this market.

(10) *Immigration.* Immigration has played a role in the growth of offshoring. A large number of Indian and Chinese citizens came to the United States to study and many of them stayed on to work. In concentrated high-tech regions of the United States, most notably in Silicon Valley, communities of Indian high-tech entrepreneurs emerged and bonded with other Indians in the high-tech community, and similarly for the Chinese. In many cases, these technical entrepreneurs were the ones who started offshoring companies or who were the go-betweens to ease the difficulties of doing business across so many miles and such different cultures. US immigration policy, especially the H1-B and L-1 visa programs, have enabled Indians and other foreigners to gain valuable experience and contacts in the United States before returning to their home countries. Recently, there has been a reverse diaspora of engineers, and China and India are both recruiting technical

workers to return permanently to live and work in their native countries. China has been providing all-expense-paid trips to China, holding job fairs in Silicon Valley, and recruiting faculty members online to spend their sabbaticals working in China. India has been providing salaries, benefits, and stock options that make living in India attractive to Indian high-tech workers who had been working in the United States.

(11) *Other factors.* Other factors have also played a role in driving or enabling offshoring. The fact that English is the language of education and business has helped make India more attractive to US firms. That India's accounting and legal systems are compatible with the British and American systems has also been an attraction. An aging population in the United States means that the country will need to reach outside its national boundaries for its workforce of the future. The McKinsey Global Institute projects a US need for 16 million additional workers from overseas over the coming decades in order to maintain the present ratio of workers to retirees. Evalueserve predicts a 5.6M worker shortfall by 2010, including a shortage of 970K IT workers (assuming no work is offshored and not counting immigrants). This shortage would lead to higher prices, being less competitive, and loss in Gross Domestic Product. US temporary visa policy (for H1-B and L-1 visas) has been conducive to building the offshore vendor presence onsite in the United States and in building networks of people between India and the United States especially in Silicon Valley. For the offshoring of research, international projects such as the International Space Station and Human Genome project have built ties, involved many countries in the international research community, and made internationalization of the R&D process seem more familiar and feasible. The following case (Table 6) of the Indian state of Andhra Pradesh and its capitol city of Hyderabad illustrates actions taken by governments interested in building up an offshoring industry.

Table 1-6: Government Action to Build an Offshoring Industry: Andhra Pradesh

In the 1990s, the Indian state of Andhra Pradesh and its capitol city of Hyderabad developed a public policy to create an IT-enabled services offshoring industry in their locale. They created a government agency with the double entendre acronym APFirst (Agency for Promoting and Facilitating Investment in Remote Services and Technology) for this purpose. The government provided free right-of-way land for laying fiber optic cable and donated a 55,000 square-foot office building with reliable electric power service to encourage IT- enabled services firms to locate there. In 1999, the government created a new incentive policy that provided 25% discounts on power bills to IT firms, exempted software from sales taxes, and provided a rebate on the cost of land by up to 20,000 rupees per job created. In 2001, the Indian School of Business was enticed to relocate to the city. The state created the Indian Institute of Information Technology to provide IT education and the Information Technology Enabled Service Training Institute to offer courses in English and other subjects of value to the ITES offshoring firms. The state also declared the ITES industry to be an essential service, thus prohibiting its workers from labor actions (just as in other critical industries such as water and police).

Sources: Atkinson (2004), Dossani and Kenney (August 13, 2004), Balatchandirane (undated "…Hyderabad…")

There are some reasons why companies might not want to offshore. These have been grouped in Table 7 into eight categories: (1) the job process is not routinized sufficiently to offshore the work; (2) the job cannot be done at a distance; (3) the infrastructure in the vendor country is too weak for the work to be carried out there; (4) offshoring the work negatively impacts the client firm's workplace; (5) there are risks to privacy, security, and intellectual property of the client company from offshoring the work; (6) there are not workers in the offshore company with the requisite knowledge; (7) the cost of opening or maintaining the offshore operation is prohibitive; and (8) miscellaneous other reasons. Although each specific reason is placed in only one category, a number of the reasons could fit in more than one category. Note that there is a certain parallelism between work that firms might offshore (Table 3) and work they are unlikely to offshore (Table 7).

Table 1-7: Reasons a Firm Might Not Offshore Work

Category	Specific Reason
Job process is not routinized.	*Uncertainty about the nature of work; uncertain specifications in some jobs. *Project has a highly iterative development process. *Applications involve complex processes that require frequent intervention to fix algorithms or data. *High-skill work such as research, process design, or business analysis. *The work involves system analysis.
Job cannot be done at a distance.	*Face-to-face interaction is required for the job. *It is too difficult to coordinate the non-standardized parts of a project if they are geographically distributed.
The infrastructure is too weak in the vendor country.	*Telecommunications, transportation, or specialty vendors are not adequate.
The offshoring impacts negatively on the client firm's workplace.	*The company loses control of the work process. *The company loses in-house expertise needed to maintain, improve, or replace the offshored product or service. *Worker morale in the client organization deteriorates because of potential loss of job, loss of wage power, or deskilling of job.
There are risks to the client company in offshoring the work.	*The work requires security clearance. *Giving the vendor's employees VPN access to the clients information systems makes security difficult. *Data privacy and security are hard to control at the vendor site. *It is difficult to ensure that the vendor will protect the client's intellectual property. *The vendor may not be able or motivated to follow the privacy and security mandates in legislation from other countries such as HIPAA, Gramm-Leach-Bliley Act, Sarbanes-Oxley Act, California State Bill 1386, and European Union Data Protection Directive. *The vendor may not be able or motivated to meet professional qualifications required to do certain kinds of work such as being an accountant certified as required by the client's country. *Legal recourse to privacy, security, or intellectual property problems is non-existent or unenforceable in the vendor country's legal system.

There are not workers in the offshore company with the requisite knowledge.	*Application domain knowledge is required to do the job. *The work crosses multiple disciplinary boundaries. *The work depends on craft or proprietary knowledge held only by the client company's staff. *The work involves business as well as technical expertise.
Cost of opening or maintaining the offshore operation is prohibitive.	*The client needs to implement new bureaucratic structures such as explicit authority relations, operating procedures, and incentive systems. *There is an extra cost for evaluating vendors, managing contracts, improving security, travel, and severance pay for laid off workers. *Alternatives to offshoring such as downsizing, consolidation, and reorganization are more cost-effective.
Other reasons	*Cultural issues exist between the vendor and client countries (social behavior, attitudes towards authority, language issues). *Gain occurs from being located near to other companies doing similar work (agglomerated economy), e.g., jobs in complex functions that need to be located near one another to thrive, adapt, and innovate such as in activities in corporate centers or less routine consulting practices.

There are also reasons that professions or countries might want offshoring not to occur. If low-level programming jobs are shipped overseas, then there might not be a viable career ladder for IT workers to climb in order to attain the higher-end IT occupations that people hope will remain in the high-wage countries. Salaries of IT workers in the client (high-wage) countries might be pushed down by offshoring. The ingredients for innovation (including labor, capital, knowledge, facilities, and technology) are threatened at home since innovation is widely regarded as the driver of higher productivity and standard of living for a nation. The locus of entrepreneurship begins to move offshore.

1.9 Is IT Still a Good Career Choice for People Working in Countries That Ship IT Jobs Overseas?

Almost every day one can find stories in the US press about people losing their IT jobs because their positions were sent to a low-wage country. Many of these stories quote talented young people who are choosing careers in other fields because they believe there are no longer opportunities in IT. There are fears that it will not only be low-level programming jobs that are sent to low-wage countries but also jobs that require higher skill levels and are more highly compensated. If the world really is flat, as Thomas Friedman proclaims, and a job can as easily be done in Bangalore or Beijing as in Boston, then even if the job remains in Boston, eventually the wages will fall in order to remain competitive with wages in other parts of the world. One study has shown that if you are one of those who loses a job to trade, the chances are that you will be paid less in your next job (Kletzer 2001).

All of this sounds bleak, but consider some interesting statistics on jobs as shown in Table 8 and on salaries as shown in Table 9. They are both based on data from the US Bureau of Labor Statistics, one of the most reliable sources available. There is some lag in collecting and analyzing data so the most recent data is only from May 2004. Note what David Patterson, a computer scientist from Berkeley who is president of the ACM, has to say about these numbers:

"Moreover, most of us believe things have gotten much better in the year since the survey was completed. Does anyone besides me know that U.S. IT employment [in 2004] was 17% higher than in 1999—5% higher than the bubble in 2000 and showing an 8% growth in the most recent year—and that the compound annual growth rate of IT wages has been about 4% since 1999 while inflation has been just 2% per year?" (Patterson 2005)

How could it be that, at the same time jobs are being shipped overseas, the number of IT jobs in the United States is growing rapidly and is even higher than at the height of the dot-com boom? There are several possible explanations, but we do not have adequate data to identify the one at play. One possible explanation is that the very companies that are sending jobs overseas are prospering from the lower costs of overseas labor which is enabling them to grow and create new jobs in the United States and elsewhere. Another possible explanation is unrelated to offshoring except that the background factors that make it possible are the same background factors that make offshoring possible, namely, many industries are being reorganized to make them more productive through the use of IT. Catherine Mann, the economist from the Institute for International Economics mentioned earlier in this chapter, has conducted a study of Bureau of Economic Analysis data for the years 1989-2000. (More specifically, her data is taken from BEA Digital Economy 2002, Table A.4.4) She has found a strong correlation for industry sectors between high productivity growth and high investment in IT (Mann 2004). She has also identified a number of sectors that still have low IT intensity and thus are poised to take off as IT is introduced. These include health care, retail trade, construction, and certain services.   As IT becomes more pervasive in society, there are more jobs involving either pure IT skills or combinations of IT skills and skills associated with a particular domain such as finance or health care. Most of the forecasts suggest that perhaps 2 to 3% of US IT jobs will be lost annually to offshoring on average over the next decade. With the expanded use of IT in society, it is very possible that the total number of IT jobs will grow at more than a 3% rate over the decade. Thus it is not surprising that the US Bureau of Labor Statistics forecasts that three IT occupations will be among the ten fastest growing occupations over the coming decade (BLS 2002).

Even if the IT job market is a growth area over the next decade, some types of jobs are likely to fall off, probably including routine programming jobs. As explained in Section 1.8, there are many reasons that companies do not send work offshore so there are likely to be jobs in almost every IT occupation to be found somewhere in the United States; but perhaps in some of these specific occupations there will be fewer jobs that there are today. It is very unlikely that the United States will be completely devoid of even these most at-risk, routine programming jobs ten years from now.

There are no fail-safe recipes for having a successful IT career, but there are many things people can do to make themselves more attractive to employers. They can get a good foundational education and keep up with current technology. They can improve soft skills such as oral and written communication and teamwork skills. They can get management training and experience. They can learn the processes of a domain in which IT is likely to be increasingly important in the future such as in the health disciplines. They can be prepared to work on tasks that are less routine and that require regular discretionary judgment or that require regular interaction with others (e.g., with customers or domain specialists within the company). They can seek out jobs that involve knowledge of trade secrets or fundamental processes of the company or that are involved with national defense. They can learn about other cultures, the technologies for doing work in a geographically distributed fashion, and other things about managing distributed work so that they can take advantage of offshoring instead of being a victim of it. They can gain a wide array of experiences so that they can be employed flexibly by a company and so that they gain an overview of the way IT is being used in the company and its industry sector.

There are also some things that American (or British or German or Japanese) society can do to assure that there continue to be good IT jobs for their workers. They can nourish the innovation base that creates these jobs. This can be achieved by adequately funding research and development, improving the educational system at all levels, making sure that there continue to be opportunities for foreign scientists and technologists to study and work in the country because of their important role in driving innovation, and developing and enforcing rules for fair competition in the international marketplace. These issues are all discussed in the policy chapter (Chapter 8).

Table 1-8: IT Employment in the United States (US Bureau of Labor Statistics)

	Employment								
					May	Nov.	May	Change, May 2003 to May 2004	
Occupations	***1999***	***2000***	***2001***	***2002***	***2003***	***2003***	***2004***	***#***	***%***
Computer and Information Scientists, Research	26,280	25,800	25,620	24,410	23210	23,770	24,720	1,510	6.50%
Computer Programmers	528,600	530,730	501,550	457,320	431640	403,220	412,090	-19,550	-4.50%
Computer Software Engineers, Applications	287,600	374,640	361,690	356,760	392140	410,580	425,890	33,750	8.60%
Computer Software Engineers, Systems Software	209,030	264,610	261,520	255,040	285760	292,520	318,020	32,260	11.30%
Computer Support Specialists	462,840	522,570	493,240	478,560	482990	480,520	488,540	5,550	1.10%
Computer Systems Analysts	428,210	463,300	448,270	467,750	474780	485,720	489,130	14,350	3.00%
Database Administrators	101,460	108,000	104,250	102,090	100890	97,540	96,960	-3,930	-3.90%
Network and Computer Systems Administrators	204,680	234,040	227,840	232,560	237980	244,610	259,320	21,340	9.00%
Network Systems and Data Communications Analysts	98,330	119,220	126,060	133,460	148030	156,270	169,200	21,170	14.30%
Computer and Information Systems Managers	280,820	283,480	267,310	264,790	266020	257,860	267,390	1,370	0.50%
Computer Specialists, All Other							130,420	130,420	
TOTAL (The "Change" columns do not include "Computer Specialists, All Other")	**2,627,850**	**2,926,390**	**2,817,350**	**2,772,740**	**2,843,440**	**2,852,610**	**3,081,680**	**107,820**	**3.80%**
Computer Hardware Engineers	60,420	63,680	67,590	67,180	72,550	70,110	74,760	2,210	3.00%
TOTAL, including Computer Hardware Engineers ("Change" columns do not include residual "Computer Specialists, All Other")	**2,688,270**	**2,990,070**	**2,884,940**	**2,839,920**	**2,915,990**	**2,922,720**	**3,156,440**	**110,030**	**3.80%**

Table 1- 9: IT Mean Annual Wages (source: US Bureau of Labor Statistics)

	1999	2000	2001	2002	May-03	Nov-03	May-04	CAGR (1999-May 2004)	May 2003 - May 2004
Computer and Information Scientists, Research	$67,180	$73,430	$76,970	$80,510	$84,530	$85,240	$88,020	5.60%	4.10%
Computer Programmers	$54,960	$60,970	$62,890	$63,690	$64,510	$65,170	$65,910	3.70%	2.20%
Computer Software Engineers, Applications	$65,780	$70,300	$72,370	$73,800	$75,750	$76,260	$77,330	3.30%	2.10%
Computer Software Engineers, Systems Software	$66,230	$70,890	$74,490	$75,840	$78,400	$79,790	$82,160	4.40%	4.80%
Computer Support Specialists	$39,410	$39,680	$41,920	$42,320	$42,640	$43,140	$43,620	2.10%	2.30%
Computer Systems Analysts	$57,920	$61,210	$63,710	$64,890	$66,180	$67,040	$68,370	3.40%	3.30%
Database Administrators	$52,550	$55,810	$58,420	$59,080	$61,440	$62,100	$63,460	3.80%	3.30%
Network and Computer Systems Administrators	$50,090	$53,690	$56,440	$57,620	$59,140	$60,100	$61,470	4.20%	3.90%
Network Systems and Data Communications Analysts	$55,710	$57,890	$60,300	$61,390	$62,060	$62,220	$63,410	2.60%	2.20%
Computer and Information Systems Managers	$74,430	$80,250	$83,890	$90,440	$95,230	$95,960	$98,260	5.70%	3.20%
Computer Hardware Engineers	$66,960	$70,100	$74,310	$76,150	$79,350	$82,040	$84,010	4.60%	5.90%
								3.90%	3.40%
								3.80%	3.30%
11					24,720	5.60%	4.10%	3.60%	3.00%
					412,090	3.70%	2.20%		
CAGR	2%				425,890	3.30%	2.10%		
1999	$100.00				318,020	4.40%	4.80%		
2000	$102.00				488,540	2.10%	2.30%		
2001	$104.04				489,130	3.40%	3.30%		
2002	$106.12				96,960	3.80%	3.30%		
2003	$108.24				259,320	4.20%	3.90%		
2004	$110.41				169,200	2.60%	2.20%		
					267,390	5.70%	3.20%		
					74,760	4.60%	5.90%		

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Chapter 2: The Economics of Offshoring

This chapter provides background material on the economics of offshoring. The first section deals with the economic theory applicable to offshoring, including discussions of why firms engage in offshoring and what economic theory indicates the consequences may be for individuals, firms, and nations. The second section covers the extent of offshoring; it first cautions the reader about the difficulties in tracking offshoring activities, and then provides estimates of current, recent, and projected offshoring activity in the United States, Europe, India, and other countries. The third section draws general conclusions about the economics of offshoring and identifies data that it would be useful to collect in order to better understand offshoring.

2.1 The Economics of Offshoring: Rationale and Potential Impacts

From a long-term view, offshoring is a response to two developments: technical change, especially in IT itself, and international differences in population and economic growth. Advances in IT have made it possible to trade in what were previously untradable (or difficult to trade) services such as software development, support, and maintenance. In particular, as discussed in Chapter 1, the development of low-cost and high bandwidth communications links that connect most corners of the globe have facilitated a massive increase in the potential to move information around the world with virtually no time lag and at low prices. This has allowed service providers in countries such as India and the Philippines and manufacturers in China to coordinate and communicate with their customers instantaneously. This ability to communicate has made a whole new set of sourcing opportunities feasible that were previously unattractive due to the high costs. More rapid population growth combined with increases in education levels outside the developed countries has meant that countries such as India, Brazil, China, and the Philippines have large numbers of young and talented workers who face limited opportunities for productive employment and therefore have received relatively low wages in the local economy. The combination of these developments makes for fruitful opportunities for gainful trade, sparked by the sustained growth in demand for IT talent since the 1990s in the United States and other developed countries.

Several additional factors make it easier for some countries than others to provide offshore services. Even relatively low-skilled service jobs generally require literacy, for example, help desk workers need to be able to look up reference material when needed. Thus, countries with more educated workers are more likely to be able to handle offshored jobs. Speaking the same language as the client nation is also beneficial for jobs requiring communication with the client country; thus, India has an advantage over China for receiving offshored work from the United States.

Some of the confusion and disagreement about the extent of offshoring stems from a lack of agreement about whether goods are included as well as services, lack of precision when applying the terms offshoring and outsourcing, and disagreements about whether direct foreign investments are included in offshoring. For a discussion of some of these issues, see Bhagwati et al.(2004).

In a free market economy, offshoring decisions are made primarily by private firms seeking to maximize profits. The decision to offshore the production of goods or services to another country can be implemented in one of two ways. A firm may choose to source the good or service from a foreign provider that could be either an unaffiliated firm or a captive

* Burt Barnow took a leadership position in the writing of Chapter 2.

organization such as a subsidiary. (A captive organization is one which has its operating decisions dictated by another organization. This might be, for example, because the captive organization is owned by the captor organization or because there are strong economic incentives for them to follow the dictates of the captor.) A firm's choice to produce a good or service itself or to outsource it to an unaffiliated firm is often referred to as the "make versus buy" decision and can apply both to domestic and offshore situations. It is worth pointing out that the degree of outsourcing of IT services to specialists has been increasing significantly in developed countries over the last decade, initially to domestic providers and recently to both domestic and offshore providers.

Firms consider any offshoring that they undertake to be in the best interests of their stockholders. The theory of comparative advantage indicates that, if each country specializes in the production of goods where it has a comparative (relative) advantage, both countries can enjoy greater total consumption and well being in aggregate by trading with each other. In our context, if providers in countries such as India have a relative advantage in the provision of software services, for instance, then it would be beneficial for US firms that utilize these services in their operations to source the services from Indian providers and focus their scarce resources on activities in which they have a relative advantage. Note that we do not say whether these are captive or outsourced providers since that decision will depend on a variety of factors such as whether the service creates valuable intellectual property. Likewise, the gains from trade are generally beneficial to the service provider's host country. In countries such as India, employees at software firms have seen significant increases in their incomes even as the number of employees such as software engineers increases rapidly. Similarly, revenues and profits at these firms are growing rapidly.

Services can also flow from developed countries to developing countries. For example, companies based in developed countries such as ABN Amro, ING Bank, Prudential, and Citibank are capturing significant market share in developing countries in numerous service industries such as banking and insurance, and displacing workers in less efficient domestic companies in these countries. In these sectors, the know-how possessed by these firms provides them with comparative advantage. As Chapter 4 discusses, some of the IT service firms headquartered in developed countries such as IBM Global Services and Accenture, are adding workers from developing countries in order to take advantage of low wages, talent, and location enabling them to compete directly with Indian software service firms such as Infosys, Wipro, and TCS in the global software services industry.

What the theory of comparative advantage does not mean is that all members of society will benefit from trade. In general, imports of an input have economic effects that are similar to those of an increase in the supply of the input, namely, lower returns to the suppliers of the input, lower costs of production, and lower prices for consumers. If the input were a service, the wages and salaries of those producing the service would fall, but so would the costs for firms that are buyers of the service. In the exporting country, the opposite effects hold. That is, the returns to the owners or suppliers of the service or input increase and the wages of the employees at the service providers increase due to the higher demand. However, there are costs as well. In the short run, assuming lead time to develop and scale service capacity, providers will often transfer capacity from a domestic market to service the export market, raising costs to the domestic consumers of these services.

There have been relatively few studies estimating the economic impact of outsourcing and most of those that exist have been based on European data and focus more on the outsourcing of intermediate goods rather than services. Several studies identify cost saving as the primary motive for outsourcing of intermediate goods, for example, Egger et al. (2003). For the United States, Feenstra and Hanson (2001) construct industry-by-industry estimates of outsourcing (of intermediate products) between 1972 and 1992 and find that outsourcing contributed substantially to an increase in domestic demand for high-skilled, non-production workers and their wages.

European studies, such as Gorg and Hanley (2004), have used plant-level data for the electronics industry in Ireland for the period from 1990 to 1995 to show that offshoring of services had a positive, though not highly robust, effect on productivity growth[1]. Likewise, Girma and Gorg (2003) find a positive impact of outsourcing of industrial services[1] on productivity in the UK manufacturing industries during 1980-1992, although they are unable to distinguish between international and domestic outsourcing.

The studies, however, did not consider offshoring of services. Recent work by Mann (2003) provides a back-of-the-envelope estimate that the first wave of offshoring, which focused on global sourcing of computer hardware, led to a reduction in IT hardware costs of 10 to 30 percent in the 1990s and an annual increase in productivity of 0.3 percentage points during 1995-2002, or $230 billion in additional Gross Domestic Product (GDP). This fall in IT costs would be reflected in higher profits for producers and lower prices for consumers. IT production workers lose, while firms and consumers gain. She goes on to argue that, since a larger share of IT costs accrue to labor-intensive tasks such as software development and systems implementation, the productivity impacts of offshoring these tasks can be expected to be significantly higher.

Economists believe that trade generally leads to significant gains to society. These gains are not inconsistent with employment losses in specific sectors that will cause economic pain to the workers affected. To achieve an equitable result, many analysts believe that it is important to establish a safety net that provides income and training opportunities to affected workers. (See, for example, Atkinson (2004); Bivens (2004); Kletzer (2004); and Mann (2004).) Components of the safety net should include unemployment insurance, wage insurance, and retraining. This topic is discussed in more detail in Chapter 8.

A key assumption underlying the theory of comparative advantage is that the economy enjoys full employment. Thus, this theory is best thought of as a theory of the long-term where workers displaced by imports or offshoring find work in other sectors. By contrast, most popular discussions of the offshoring phenomenon tend to focus on questions such as "where will the new jobs be created" and "can the workers be retrained for these new jobs"? In general, peering into the crystal ball to predict where and what types of new jobs will be created is both difficult and unrewarding. A dynamic economy, such as that of the United States, creates and destroys millions of new jobs in response to changes in tastes, and more importantly, innovations and advances in technology. The US economy creates and destroys more than 30 million jobs each year. In 1999, 32.9 million jobs were lost and 35.5

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[1] The authors find that international outsourcing generally had a positive effect on productivity, of which the effect on the level of productivity can be attributed to outsourcing of material inputs. Similarly, for international outsourcing of materials inputs, Egger, Pfaffermayr, and Wolfmayr-Schnitzer (2001) find outsourcing of material inputs by Austrian manufacturing firms to the Eastern transition economies increases domestic growth in total factor productivity, more so in capital-intensive industries than in labor-intensive ones. Egger and Egger (2003) find that a 1 percent increase in outsourcing of intermediate inputs to the Eastern countries relative to gross production induces a shift in relative employment by about 0.1 percent in favor of high-skilled labor. Egger and Egger (2001) find that outsourcing of intermediate products by EU manufacturing firms reduces productivity of low-skilled workers in the short-run and increases it in the long run, an effect which the authors attribute to imperfections in the EU labor and goods markets.

[1] This study defines "industrial" services as "activities such as processing of inputs which are then sent back to the establishment for final assembly or sales, maintenance of production machinery, engineering or drafting services, etc." (p. 5). They do not include "non-industrial" services such as accounting, consulting, cleaning, or transportation services.

million new jobs were created for a gain of 2.6 million jobs. In 2003, there was a net loss of 100,000 jobs even though 30.2 million new jobs were created (BLS Business Employment Dynamics). There is no guarantee that the economy will continue to create these new jobs, but we can take some comfort from the historical evidence that thus far it has managed to do so. The key to job creation is of course the ability of the economy to rapidly generate and adopt innovations, that is, new types of goods and services, and productivity-enhancing process improvements.

Innovation is indeed an engine of economic growth, and perhaps the most important source of productivity growth in developed economies. When there is rapid technological innovation, as in the case of IT, there is a significant spillover effect to users of the technology when the price paid for the technology is lower than the value received. This can result in significant productivity and economic growth in the user sectors as well. Given that IT is a general-purpose technology, the users are many and varied.

In general, trade stimulates innovation and economic growth in both trading partners. However, Gomory and Baumol (2000) and Samuelson (2004) argue that innovation opportunities create new possible conflicts of interest between trading partners. For instance, insofar as offshoring stimulates innovation and productivity growth in countries such as India, and more likely, Brazil, China, and Israel, in goods and services for which developed countries such as the United States or Germany enjoy a comparative advantage, this will cause the terms of trade to become less favorable for the developed nation. Simply put, the comparative advantage of the developed nation becomes less valuable over time. As a result, offshoring may impose permanent losses in the developed nation. In other words, even if free trade is the best policy, it may well be that free trade, by stimulating innovation overseas, may impose long-term losses. However, Gomory and Baumol's analysis shows that this conflict of interest is present when the two trading partners are at similar stages of development. Since most offshoring involves countries at very different levels of development, this conflict of interest is presently unlikely.

In the IT services sector, there is a related concern in the developed nations, particularly in the United States. Currently, it is efficient to offshore low-end IT services such as coding or maintenance, with high-end activities such as requirements analysis, design, and research and development remaining in the developed country. However, the concern is that eventually the "labs will follow the mills", and high-end IT activities will also move offshore. Were this to happen, the developed country might cease to be the technology leader. There is some anecdotal evidence that some process innovations are moving offshore. For example, in laptops, it used to be the case that contract manufacturers made product to the design specifications of US vendors. Today, many of these companies have moved upstream to design the product. Intel is designing processors at its R&D facility in India. Likewise, software services firms have moved upstream to provide increasingly sophisticated software solutions from more traditional applications, and to business process services such as accounts payable, human resources, and even medical applications. Thus, in addition to the static, resource allocation efficiency from free trade, one must also look at the impact on the fundamental capabilities that underlie innovation.

These concerns reflect possible scenarios, perhaps even plausible scenarios. However, it is not clear how likely they are. There are offsetting forces as well. In parallel with offshoring, the inflow of skilled and trained workers into the United States has grown. Though perhaps these inflows substitute for native-born workers in the short run, in the longer run, they create all-around benefits by raising innovation. Moreover, it could be argued that even a loss of technical leadership in one area could be beneficial by allowing scarce talent and resources to be allocated to more promising areas such as nano-technology, bioinformatics, or genomics. The post-9/11 trend of a reduced rate of immigration should be of concern to the United States given that many other developed countries are seeing increases in immigration of qualified professionals.

Arora and Gambardella (2005) suggest that the scenarios that result in a loss of US technological leadership are very unlikely. In many industries, the locus of production and the locus of invention are physically separated. This is particularly true when the body of knowledge underlying the invention process has a strong scientific basis. Building on earlier work by Lamoreaux and Sokoloff (1996; 1997), Sutthiphisal (2003) studied the location of production and invention in three different industries during the Second Industrial Revolution, namely, textiles, shoes, and the electric industry. He finds that, in general, the locus of invention did not shift with the locus of production as the latter moved to other locations. Moreover, he found that the link between location of production and invention is weaker in the more science-based electric industry. Using data from a century later, Mariani (2001) studied the location of R&D and production facilities by the Japanese multinationals in Europe. She found that in low- and medium-R&D industries, R&D labs are more likely to be located close to production facilities than in more R&D-intensive industries. Chapter 5 discusses some of the current patterns in the globalization of research.

Can the United States specialize and keep its comparative advantage in the higher end? The starting point for this discussion is to note that there are two key resources required to remain the center of innovation in software: access to talented designers, software engineers, and programmers along with proximity to a number of large and technically sophisticated users. The United States dominates on both counts. Recall that in the 1990s, there was considerable concern about Japan's software factories (e.g., Cusumano 1991), but there has not been a single successful Japanese software product that has developed a global market (if one excludes the software that is a key component of gaming devices which is not sold separately). To the extent that students are misreading the tea leaves and moving away from studying computer science, the United States in particular could face a longer-term problem in having access to talented software professionals. This topic is discussed in Chapters 7 and 8.

The size and the openness of its culture and economy have given the advantage to the United States over Japan and Western Europe in attracting talent from around the world. The United States has been and continues to be a large producer of IT human capital for the world, especially at the graduate level, and some of the students who study remain to work in the country after graduation. The country has also been a magnet for technical workers trained elsewhere. The United States as a destination for study and work has abated somewhat in the past several years partly because of the harsher governmental regulations in support of national defense.

Another global advantage of the United States is that most lead users are US-based. New software applications depend largely on knowledge about demand and about the applications domain. This is especially true for the substantial fraction of software used in running businesses and business processes. Proximity to business activities is crucial for innovations in such areas. Indeed, the development of new commercial applications or solutions is a very special comparative advantage of the United States. On a more limited basis, this benefit also accrues to other developed countries such as Germany where the software giant, SAP, is based and dominates the market for enterprise software. In general though, US industry is the largest user of IT in the workplace.

Globalization may reinforce this lead because we find that innovative companies from Israel, Ireland, and even India are likely to move their operations to the United States to be closer to their users. Sometimes, venture capitalists push for such a move as well. Other intermediating institutions, such as legal services and thick and well functioning labor markets, are also important sources of advantage enjoyed by the United States that are not likely to be eroded soon.

There are counter-tendencies as well. In so far as these professionals (be they Indian, Irish, Israeli or Chinese) have a preference for staying in their home country where the cost of scientists and engineers is lower, the cost of R&D activities that are human-capital-intensive and relatively less intensive in physical infrastructure will also be lower offshore.

More broadly, the United States has several distinct capabilities – the best universities and research institutions, highly efficient capital markets, flexible labor markets, the largest consumer market, business-friendly immigration laws, and a large and deep managerial talent pool. As a result, the evolution of business in the United States has followed a consistent pattern: launch innovative businesses here, grow the business, and as products and services mature, migrate lower-value-added components and intermediate services over time to lower-cost countries. As more countries and regions enter global trade with highly skilled and capable labor pools, this increases the amount of competition that US companies and workers face. This competition produces an increased premium on the innovation and productivity of the US workforce.

To continue growing the wealth of the United States and its individual workers, labor productivity must grow at a rate that equals or exceeds the growth of wages. Labor productivity can increase in a variety of ways but generally occurs through an increase in worker skills combined with increased innovation in products and processes. Essentially, growth requires capital investment in technologies that increase productivity and a focus on innovation that results in new or transformed existing marketable products and in more efficient processes.

In summary, economists have argued on both sides of the offshoring and free trade issue. The arguments are sophisticated and nuanced, and the results often depend on whether the underlying assumptions hold in the current context. While a majority of economists are proponents of free trade, the underlying question is an empirical one and can be answered by analyzing reliable data. As someone once said, "The difference between theory and practice is greater in practice than in theory." Unfortunately, there is a lack of data to help understand the phenomenon, and more importantly, there are no data collection processes underway that would help in conducting a statistical analysis of the empirical evidence.

It is important to distinguish among effects at the country, firm, and worker levels. Because it is voluntary, offshoring benefits the firms that undertake it. Workers, on the other hand, sometimes lose substantially from offshoring because they cannot instantly (and may never) transfer their skills to other jobs that pay as well. At the country level, the benefits of trade often outweigh the costs, but we have seen that this is not always the case.

2.2 Data on the Current State of Offshoring and Projections for the Future

"…there are currently no reliable statistical indicators of the extent or nature of global outsourcing." (Huws et. al. 2004)

The report that triggered public concern about the impact that offshoring would have on US lives was produced by Forrester Research in 2002, indicating that 3.3 million US service jobs would be lost to offshoring by 2015. This report was followed by many additional studies, each with its own numbers, produced by private consulting firms, federal agencies, and economists from academia and think tanks. These numbers ranged quite widely, in some cases differing by a factor of ten. How are we to know which numbers are correct? This section discusses some of the general issues concerning data about offshoring. It then considers what the existing data tells us about the current state of offshoring and about projections of future offshoring activity. The greatest emphasis is on the United States (the leading sending country), then on India (the increasingly dominant recipient country), but data are provided about all the countries actively involved in offshoring to the degree that we could identify data. Worldwide data was given in Chapter 1 and is not repeated here.

What Are the General Issues We Should Consider in Evaluating the Accuracy of Data About Offshoring?

There are three basic points to consider in evaluating offshoring data. First, there is a question of the definition of offshoring. Some reports include all service jobs, some include a subset of the service jobs that pertain to professional and technical services (following a category used by the Bureau of Labor Statistics (BLS) in the U.S. Department of Labor), some include all IT jobs, some include only software jobs, some include IT-enabled service jobs, some include other jobs with other criteria, and some reports are not precise in defining what they are counting. Obviously, the numbers will vary considerably based upon the definition used.

Second, it is not clear what should be considered a good measure of the extent of offshoring. Many people count jobs or workers. In addition to the issue raised in the prior paragraph about what kinds of jobs one has in mind, there are other considerations. Suppose one wants to count the number of jobs lost in the United States or Western Europe to offshoring. How does one know which jobs to count? Business decisions by companies are complex and, while the press sometimes reports horror stories of employees being asked to train IT workers from a low-wage country and afterwards being replaced by them, it is rarely clear-cut whether a job has been lost directly because of offshoring. A company might cut back on the number of workers in one location and add workers in another location, or cut back on people in one occupation and replace them with workers in another occupation. And this might be because of some good business reason other than labor arbitrage that is taking advantage of the wage differentials in the two countries to save on labor costs. It might be, for example, that one product line is declining and resources are needed elsewhere in the company, or the company needs fewer workers in a particular field because of automation of some aspects of the work or rationalization of the work process, or because the company has a global strategy that it is trying to achieve and part of that strategy involves building market presence in specific geographic locations.

One might instead want to count the number of jobs created in a low-wage country to do offshoring for a high-wage country. There is, however, no necessary correlation, for instance, between the number of Indian jobs created and American jobs lost. A company might decide to hire more Indian workers to work on a project than the number of American workers displaced because the cost of the Indian workers is so low and better results might occur by dedicating a larger labor effort to it. An American worker and an Indian worker might not have the same productivity rate because of educational level, work process, infrastructure, technical tools available to support the work, or many other reasons. The literature gives examples where American workers are clearly more productive than the Indian workers, and other examples that show the opposite. In particular, work processes often are reengineered before being implemented in India, and the reengineered process sometimes leads to significant increases in productivity. Also, in some lower level jobs (for example, working in a call center), Indian companies are on average able to recruit workers to do these tasks who are much more highly educated than the average American holding that job. There is also confusion in the statistics about whether to count only the jobs newly created that are focused on doing software work for export versus counting all new and existing jobs with this focus.

One might want to focus on the monetary value of the business rather than on the number of workers who perform the work. This, too, is difficult to measure. One of the problems is that a significant portion of the work that is done for multinational corporations is done by their subsidiaries in countries such as India. The work that is conducted is then regarded as an internal operation of the multinational, and this may make it difficult to identify the monetary value of the work performed offshore or even to know when to consider something as offshoring and when to regard it simply as a product or service developed by a multinational through several of its divisions located in different countries. This is a serious issue in measuring offshoring because balance-of-payments data tells us that intrafirm trade represents 71% of all business, technical, and professional services imported into the United States and, moreover, in the period 1997-2002, it was increasing faster than imports from companies not affiliated with a multinational (UNCTAD 2004).

Another issue is that offshoring of complex products or services often occurs by dividing up the labor and having some of it done within the client company, some done by one or more vendors, and some purchased as components. In these cases, it is often difficult to value fairly the portion of the product or service that has been outsourced. A recent European study addressed these issues:

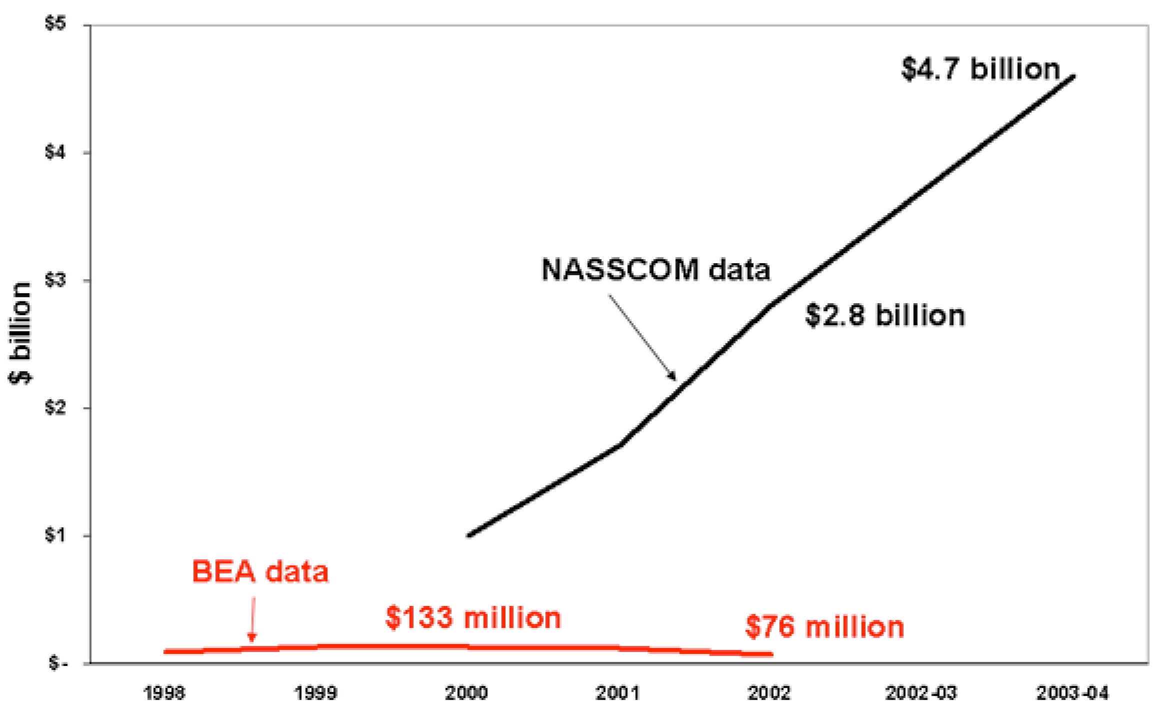
> In its legal sense "outsourcing" refers to a business activity, involving the production of either goods or services, purchased by an organization from an external supplier rather than internally. It is, in other words, "subcontracting." However, in the current context of rapid organizational change, determining what is "internal" and "external" is increasingly difficult. Mergers, demergers, strategic alliances, public-private partnerships, and a variety of different forms of organizational disaggregation – including those resulting from business process re-engineering – are increasingly common. If a company is restructured on the basis of separate cost or profit centers, for instance, should transactions between them be regarded as 'outsourcing' or merely as internal accounting flows?" (Huws et. al. 2004, p. 3)

If one wants to focus on the long-term impact of offshoring, the appropriate metric might be jobs lost or created, or the monetary value of offshoring business over time rather than at any specific point in time such as today. This kind of data tends to be of two types. One type analyzes the nature of work to determine the number of jobs that might be vulnerable to offshoring without making any claims that all or any particular portion of these jobs would be transferred from the high-wage to a low-wage country. The other type analyzes the number of jobs that will actually be sent overseas (or the monetary value of actual offshoring business) by a certain date. Even in cases where the methodology is sound and soundly applied, projections about the future are much less likely to be accurate than data about today's or yesterday's situation since it is difficult to predict all the factors that will come into play over time.

These two types of analyses introduce additional data issues. Vulnerability analyses are less prone to errors because they require fewer assumptions than the other types of analyses. To conduct a vulnerability analysis, all that is required is to identify industries whose work could be transferred offshore and count the number of workers and their occupations in the identified industries. To some extent, the list of vulnerable industries is subject to change as new technologies and price changes can affect the list of industries that are vulnerable to offshoring. A more important problem with vulnerability analyses is that they tend to produce very large numbers that may bear little relationship to the actual amount of offshoring that will take place. For example, all manufacturing, mining, and agricultural activities could be replaced by offshore activities. Thus, other than pointing out which industries and occupations are immune from offshoring, assessments of the number of jobs vulnerable to offshoring provide a very high upper bound that may be of little practical value. As described in the following, projections of how much offshoring will occur, while more useful in theory, are plagued by additional problems.

In addition to issues with the definition of offshoring and what constitutes a good measure of it, there is an issue concerning the source of the statistics. There are four major categories of data providers: government agencies, trade associations, consulting firms, and universities and think tanks. At least in the United States and Western Europe, the national governments provide data that is among the most trustworthy. For example, the US government collects large and often fairly complete data sets, taking advantage of its ability to compel business organizations and individuals to report certain kinds of data under penalty of law. Most of these federal agencies employ well-trained and experienced economists and demographers who typically use appropriate methodologies and open their methods and assumptions to scrutiny. In the United States and a number of other countries, the data-collecting and reporting agencies have been relatively unbiased – not subject, for example, to political whims but instead trying honestly to determine what the data tells us. Some analysts have argued, however, that US government data and reports may indeed be either inferior to data from other sources or biased. For example, the Economic Policy Institute (2004) has noted that the Bureau of Economic Analysis (BEA) data on US imports of software from India shows much lower levels and a different trend (flat or declining compared to a rapid increase) than data provided by NASSCOM, the Indian trade association (see Figure 1). Business Week Online (2005) points out how the tone in US Department of Commerce reports on the effects of offshoring changed markedly when one of their reports was updated with the authorship shifted from career staff to political appointees.

Figure 2-1. U.S. Software imports from India



Source: Bureau of Economic Analysis and the Indian National Association of Software and Service Companies (NASSCOM).

Projections, however, require more than simply collecting and analyzing data. Models must be developed to extrapolate trends, and decisions must be made on turning points and when new forces will affect trends. Thus, it is not surprising that projections related to offshoring, and other labor market variables as well, are subject to error, particularly when projecting over longer periods of time. Even federal agencies are often far off the mark with projections especially if these projections extend far into the future. The BLS periodically assesses the accuracy of its projections. The most recent BLS review of its general occupational projections shows that although BLS does reasonably well in projecting overall employment in broad occupational groupings, the projections do not do as well in dealing with specific occupations (Alpert and Auyer 2003). In projecting employment growth from 1988 to 2000, the BLS projected an increase of 15.3 percent, but employment grew by 21.7 percent over the period. The most serious problems in projecting occupational employment patterns resulted from problems in anticipating changes in staffing patterns. Examples of particularly large errors include the category of gas station attendant, which was projected to grow from 308,000 to 331,000, but actually fell to 140,000, and travel agents, whose ranks were expected to grow by 54 percent but whose numbers declined by 6.2 percent (Wessel 2004). An earlier outside review of the BLS occupational projections found that BLS tended to underpredict the growth of occupations requiring a college education (Bishop and Carter 1991).

Even when government agencies do a good job of collecting data and making projections, they generally collect data that helps them assess issues that have occurred in the past so when a new phenomenon arises (such as offshoring), it is not clear that the data that federal agencies have been collecting and the analyses they have been performing will answer the policy questions that now arise. This is generally true for both the federal data from most countries and for the data collected by pan-national organizations such as the United Nations, the International Monetary Fund, and the Organization for Economic Cooperation and Development (OECD).

The data provided from the other sources is potentially more problematic. Trade associations, such as the Information Technology Association of America (ITAA) and the National Association of Software and Service Companies (NASSCOM), the trade association for the software industry in India, have access to large data sets from their members. However, the members of these organizations are not necessarily representative of the totality of producers or consumers of information technology so the data from these organizations may not accurately represent the full story of what is going on. Moreover, these organizations are partisan to their members, and they may craft their data studies or reporting of these studies in ways that are favorable to the interests of their membership.

The consulting firms have a strong interest in increasing their business based on their statistics. It is in their interest to provide numbers that demonstrate to potential clients that there is a problem that needs fixing. Most of the consulting firms keep proprietary the method by which they produce their projections so it is hard to evaluate what their numbers mean. In fact, many economists are skeptical of the methods these firms use. Much of the alarmist data about the impact of offshoring on job loss in the United States and Europe has been generated by the consulting firms. All of this discussion indicates that it is difficult to get accurate data about the amount of offshoring currently going on and that is likely to take place in the future.

What Does the Data Tell Us About the Size and Impact of Offshoring in the United States?

Although the Forrester Research numbers are the most widely quoted, it would be preferable to be able to use other sources because Forrester is an interested party and the firm is not forthcoming about its methodology. One would like to use US federal data, if possible, for quality and objectivity. The most relevant federal data source is the Bureau of Labor Statistics Mass Layoff Statistics (MLS) series. Unfortunately, the MLS has serious shortcomings for this purpose in that it both undercounts and overcounts layoffs. It counts only relatively large layoffs (at least 50 employees within a five-week period) and only layoffs at companies that employ at least 50 employees; thus it undercounts by not counting all small businesses and by not counting companies that lay off people for offshoring purposes in smaller numbers or over a longer period of time. The MLS also overcounts in that its numbers include people who are laid off for many reasons, including a number not relevant to our interest such as bankruptcy, financial difficulties of the company, movement to other locations within the United States, or change of company ownership. BLS reports that these latter reasons are more common than layoffs for outsourcing, both domestic or across national boundaries.

For the IT industries (by which the BLS means the communications equipment, communication services, computer hardware, and software and computer services), MLS only identified 7,923 people affected by movement of their jobs during the period January through September 2004. Of these job relocations in the first three quarters of 2004, 70% of the jobs were moved within the United States and 80% were moved within the same company. When the jobs were moved contractually to another company, 40% of the jobs were moved outside the United States. These numbers appear unreasonably low.

A study by Bronfenbrenner and Luce (2004) used online media tracking and corporate research to identify offshoring job losses in the United States. This study found that the MLS grossly underreported job loss due to offshoring. It estimated that 206,000 jobs were shifted overseas in 2002 and 406,000 were moved in 2004. The authors argue that their method, while imperfect, probably undercounts job migration because not all losses are reported in the media and their search tools did not fully capture job losses that are reported only in the local media, a common place for such losses to be reported.

[2]Even if the MLS data does not provide exact numbers, it might serve as a representative sample from which one could learn about trends (for example, the year in which losses peak in a particular field of IT). If this sample is indeed representative, computer hardware, software and computer services, and communications equipment had their peak losses in 2001, while communications services had its peak losses in 2002. The Bronfenbrenner and Luce study discovered that the largest job losses came from the midwestern states in the United States, and that there have been rapid increases in job movements in IT, call centers, and white-collar jobs to India.

Another potential source of federal data on offshoring comes from the US Department of Commerce's Bureau of Economic Analysis (BEA). However, some economists believe that the BEA numbers seriously underreport software imports to the United States. For example, BEA reports the United States imported $76 million in software from India in 2002, whereas the Indian software trade industry association NASSCOM reports Indian software exports to the United States at $2,800 million that same year (see Figure 1). A small part of this difference can be attributed to differences in definitions but not nearly the entire amount. The US Government Accountability Office (GAO) noted the shortcomings of the BEA data on offshoring as follows: "In addition to the lack of quarterly survey data for unaffiliated transactions and lack of quarterly product detail for affiliated services, there are reliability issues related to the mandatory filing requirements and survey coverage." (Government Accountability Office 2003, p.62).

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[2] This study defines "industrial" services as "activities such as processing of inputs which are then sent back to the establishment for final assembly or sales, maintenance of production machinery, engineering or drafting services, etc." (p. 5). They do not include "non-industrial" services such as accounting, consulting, cleaning, or transportation services.

The BEA data nevertheless show some trends. Imports of business, professional, and technical services into the United States increased by 77% to $38 billion between 1997 and 2002. US investments in developing countries that offshore services were small compared to investments in developed countries, and most services created abroad are sold to non-US markets.

Turning to trade association data about offshoring and the United States, the Information Technology Association of America (ITAA) is the principal provider. ITAA is an organization that represents 350 US-based Internet, software, service, and telecommunications companies. It reports that 372,000 software and services jobs were lost between 2000 and 2003, with only 104,000 lost to offshoring. ITAA estimated that 90,000 new software and service jobs were created in the United States in 2004 due to increased economic activity.

The largest amount of data (that is also the most suspect data) comes from the consulting firms. Table 1 provides information about the impact of offshoring on the United States based on reports and projections from consultants. The numbers generally indicate that 12 to 14 million IT and IT-enabled jobs in the United States are vulnerable to relocation through offshoring. Annual losses range from under 200,000 to about 300,000 for service jobs lost from the United States due to offshoring. The number of IT jobs lost is somewhat lower than these estimates because the estimates include service jobs such as working in call centers and possibly in other IT-enabled services such as business process and knowledge process outsourcing. The numbers from the American Electronics Association might seem to be contradictory to the other data, but it should be remembered these are net losses in the industry so they include losses not only to offshoring but for other reasons such as company downsizing or bankruptcy, and these losses are offset by newly created jobs. The consensus seems to be that about 20% of US companies are currently offshoring work but that the percentage will rise considerably over the coming years. Bednarzik (2005) concludes that "employment trends by industry and occupation suggest that offshoring in the information technology sector occurs, but not to a great extent." These numbers also do not take into consideration jobs that are created by offshoring.

The current value of offshore contracts from the United States seems to be in the $10 to 20 billion range, and most analysts believe there will be rapid growth in these numbers over the coming few years. It should be remembered, however, that we do not know the methods used to arrive at these numbers and how independent the data from one consulting firm is from that of another. We do not know, however, of any body of extant raw data that serves this analysis well.[BSB1]

Table 2-1: The Impact of Offshoring on the United States

Source	**Data reported**	**Statistic**
I. Current or Recent Offshoring		
Forrester (2004)	US service jobs lost in 2003	315,000
Forrester (2004)	US service jobs lost by end of 2005	830,000
Goldman Sachs (2004)	US jobs lost in past three years	300,000 to 400,000

Dossani (2005)[BSB2]	Software workers in the United States	1,200,000 software engineers; 500,000 programmers
Evalueserve (2004)	IT jobs offshored year ended March 2004	212,000 (60% to India)
Evalueserve (2004)	Call center jobs offshored year ended March 2004	136,000 (90% to India)
Gartner (2004)	Fortune 500 companies expected to offshore some IT work by end of 2004	40%
Gartner (2003)	IT industry and employment	500,000 jobs by end of 2004
Meta Group (2004 Annual IT Staffing and Compensation Guide)	US companies using offshore labor in software	19%
American Electronics Association (2003 Cyberstates report) [Seeley 2003]	Jobs lost in 2002 in the US software services sector	30,000 (compared to 146,000 the year before)
American Electronics Association (2003)	Jobs lost in 2002 in the US software industry	150,000
American Electronics Association (2003)	Jobs gained in 2002 in US in high-tech R&D	7,000
Washington Alliance of Technology Workers (CBSNEWS.com, 2005)	Jobs lost in the US IT sector March 2001 to April 2004	403,300
Washington Alliance of Technology Workers (CBSNEWS.com, 2005)	Percentage of IT sector jobs in San Francisco area lost March 2001 to April 2004	49%
United Nations Conference on Trade and Development (World Investment Report 2004)	Average percentage annual growth in US imports of computer and data processing services, 1992-2002	31%
Bajpai et al. (2004)	Percentage of companies that have offshored work (survey is mostly but not exclusively of US companies)	25%
Bajpai et al. (2004)	Percentage of companies that have already or plan to offshore work	79%
IDC	Value of offshore contracts from US in 2005	$17.6 billion

ITAA[BSB3]	Value of offshore contracts from US in 2003	$10 billion
II. Estimates of Workers Vulnerable to Offshoring		
Bardhan and Kroll (2003)	US workers in service jobs vulnerable to offshoring	14,000,000
Progressive Policy Institute (2004)	US IT jobs vulnerable to offshoring	12,000,000
III. Projections of Offshoring		
Wired magazine (Pink 2004)	Service jobs leaving the United States each year for the foreseeable future	200,000
Prism (2004) meta-analysis	Percentage of IT jobs lost from US over next five years	7% to 8%
ITAA[BSB4]	Value of offshore contracts from US in 2008	$31 billion
Deloitte Research (2003 report cited in GAO 2004)	Financial services jobs that may move offshore	850,000 (15% of industry employment)
Forrester (2004) report cited in GAO (2004)	U.S. service jobs lost by 2015	3,300,000
Goldman Sachs (2003 report cited in GAO 2004)	Services and manufacturing jobs lost over coming decade	Up to 6 million jobs
Evalueserve (2003)	All jobs lost 2003-2010	1.3 million worst case
Evalueserve (2004A)	Total jobs offshored in IT and non-IT business process operations (BPO) in 2010	775,000 IT jobs 1,414,000 non-IT BPO jobs
Evalueserve (2004B)	Growth of value of knowledge process offshoring (KPO) from 2003-2010	From $1.29 billion in 2003 to $17.0 billion in 2010 (46% annual growth rate)
Shaw quoted in McDougall (2005)	IT jobs moving offshore in 30 years	30% of IT jobs offshore within 25-30 years
Gartner quoted in McDougall (2005)	Percent of U.S. IT jobs offshored in 2005 and 2015	Will increase from 5% in 2005 to 30% in 2015

Two studies estimated the number of jobs in the United States that are vulnerable to offshoring, and they found 12 to 14 million jobs could be offshored (Bardhan and Kroll 2003; Progressive Policy Institute 2004). Both studies note that their figures represent an upper bound on offshoring activity that could occur not a projection of what will take place. Thus, these studies are useful not so much for the numbers they provide as for identifying sectors and occupations subject to offshoring. Bardhan and Kroll, for example, include in their 14 million jobs vulnerable to offshoring office support, business and financial support, computer and mathematics professionals, paralegals and legal assistants, diagnostic support service jobs, and medical transcriptionists.

A number of studies provide projections of offshoring activity in the United States. It is difficult to make comparisons among the studies for several reasons. The major obstacle is that the studies measure different sectors of the economy (e.g., IT, services, manufacturing, business processing operations, knowledge process offshoring), use different measures of the extent of offshoring (e.g., jobs lost, percent of jobs lost, value of jobs or business lost), and different start and end points. Few of the studies provide details on how they developed their projections which makes it difficult to assess the reasonableness of the assumptions and the soundness of the methodology. The Evalueserve studies provide more details on their methods so one can assess the assumptions and methods better than for most other studies. For example, a critical assumption in Evalueserve's work is that there will be a large shortage of labor in the United States and that a significant part of the solution will be from offshoring. Since Evalueserve has described its assumptions and methods in some detail, other analysts can make their own assessment of how reasonable these assumptions and methods are.

All the projections indicate that offshoring of service jobs in the United States in general and of IT jobs specifically will continue to grow, but there is some disagreement about how rapidly the growth will take place. Some of the studies project absolute numbers of workers lost over a given number of years such as Forrester's projection of 3.3 million service workers by the year 2015. The problem with these projections is that most of them do not give a baseline for understanding the significance of the job losses. They often do not tell you the size of the population from which these projected losses will be taken. In fact, it is a difficult task to count the number of IT or service workers in the United States. Here is one part of a lengthy analysis of this issue from a Computing Research Association study done in 2000 about the IT workforce.

> Commerce used the narrow definition of the Bureau of Labor Statistics classifications: computer scientists and engineers, systems analysts, and computer programmers. The Information Technology Association of America (ITAA) used a broader definition: any skilled worker who performs any function related to information technology, which itself is defined as the "study, design, development, implementation, support or management of computer-based information systems, particularly software applications and computer hardware." (Freeman and Aspray 2000)

Not surprisingly, different definitions lead to different numbers. The Bureau of Labor Statistics counted a little more than 2 million workers in 1997 and about 3 million today. Between 2000 and 2004, the ITAA has counted between 10 and 11 million IT workers. Service workers account for a very significant portion of the American labor force, amounting to many tens of millions of workers. Some significant fraction of these service workers are enabled by information technology, but it is hard to count how many and to what extent.

Some of the other studies project in terms of the percentage of the jobs lost. These vary significantly in the percentages they quote and the length of time over which this job loss takes place. But perhaps more importantly, it is hard in some cases to know what a given percentage projection means or to compare across these projections by different organizations since their meanings are often different from one another. When a study says that 25% of the US IT jobs will be lost by a given year, does it mean that the IT workforce in the United States will be a quarter smaller than it is today? Does it mean that there will be three IT jobs in the United States at that date in the future for every IT job in another country doing work for a US firm? Are the numbers calculated on a base of the number of IT jobs today or at that time in the future? Would it matter if there were a sizable number of IT jobs in other countries servicing the US economy if the number of IT jobs that remained in the United States continued to grow?

Some of the projections are for specific slices of the offshoring market. For example, Evalueserve (2004B) has projected a high rate of growth—46 percent annual compound rate of growth—in what they term knowledge process offshoring (KPO). Evalueserve distinguishes KPO from other business process operations (BPO) by the high level of knowledge intensiveness required. Examples of opportunities in KPO include intellectual property research; equity, financial, and insurance research; data search, integration, and management; analytics; and research and information services in human resources (Evalueserve 2004B, p. 4). What happens in the KPO slice that is developing from a small base, making it easier to have high growth percentages, may well not be true for other segments of the offshoring industry.

How do we put all this in perspective? Looking only at the number of jobs lost to offshoring is a narrow and one-sided way of looking at the situation. If one wants to know how many jobs there will be for IT workers in the United States in the future, one needs to look not only at all the ways in which jobs are lost (including not only those moved offshore but those lost through companies downsizing or going out of business) but also look at the number of new jobs that are created in the IT occupations.

It is useful to consider what has happened over the past five years and compare that situation with some of the projections just mentioned about IT job growth. The reports discussed earlier in this section indicate that the United States has lost several hundreds of thousands of jobs to offshoring since the height of the dot-com boom. Does that mean that we have fewer jobs today in the United States in the IT field than we did then? The last section of Chapter 1 contains an analysis of recent US Bureau of Labor Statistics numbers (see Table 8). It shows that the number of US IT workers is actually higher today than in 1999, at the height of the dot-com boom, despite the hundreds of thousands of jobs lost to offshoring. People who study the overall US labor market will not be surprised to learn that the situation is not as dire as it is made out to be by those who dwell on the offshoring losses. This is because history shows tremendous and continuing churn in the American labor market with massive numbers of jobs lost and jobs created each year, but with a fairly consistent pattern that the number of jobs created is larger than the number of jobs lost. These patterns do not hold true for all occupations of course, we have significantly fewer telephone operators than we once had, for example, but the Bureau of Labor Statistics in its ten-year forecasts continue to believe that the IT occupations will experience overall sustained growth and, in fact, several IT occupations will be among the fastest growing occupations in the next decade. The ITAA study mentioned previously also suggests that the number of IT jobs created in the United States in the future will be robust.

One can similarly ask about the effect of offshoring not on jobs but on wages for US IT workers. The same Bureau of Labor Statistics data just cited indicates that, since the height of the dot-com boom and throughout the dot-com crash, even through a recession in the US economy, IT wages have continued to rise at about twice the percentage of inflation. Wages did not rise at the same rate in all IT occupations. High-skill jobs rose at the highest rates, for example, computer science research salaries rose at 5.6% per year and computer systems manager salaries at 5.7% per year. Wages for low-skills jobs rose less rapidly. For instance, computer support personnel wages rose at only 2.1% per year, fairly close to the rate of inflation during this time. Even the much talked about programmer, whose job is expected to be particularly vulnerable to offshoring, had wages rise by a healthy 3.7% per year.

What will happen in the future is hard to predict. If the United States remains innovative in the IT field and if this innovation continues to have an important positive influence on the US economy as was the case throughout the 1990s, then it is likely that the United States will continue to create large numbers of jobs for IT workers. If the country does not continue to promote innovation and it cedes large portions of its IT industry to other countries, then the future is likely to be much bleaker for American IT workers.

What Does the Data Tell Us About the Size and Impact of Offshoring in Countries Other Than the United States That Offshore Work?

EUROPE OVERALL

The European Union is the largest offshorer of IT software and services after the United States. In one project of the European Commission's Information Society Technologies Programme, known as the STILE project, there was an effort to cull data on the IT-producing sector in Europe. The study group tried to use the accepted classification scheme, Nomenclature Generale des Activites Economiques dans les Communautes Europeenes (NACE) (General Industrial Classification of Economic Activities within the European Communities). They found that this was not particularly useful because IT activities are in many cases bundled with non-IT activities in the classification codes, and it was impossible to separate out services from products. More generally, there seems to be very little data, if any, collected by government organizations that provides information about the state of offshoring in Europe. As one major survey of the literature on European offshoring summarizes:

> It is important to emphasize, along with the OECD (van Welsum, 2004) that there are currently no reliable statistical indicators of the extent or nature of global outsourcing. It is not possible, either through the trade statistics or the EU occupational and employment statistics, to track statistics of imports and exports of business services to identify with any accuracy which components of these services represent jobs.
>
> For evidence we must therefore look to the results of market research, one-off surveys and case studies or anecdotal evidence. It must be emphasized that these vary in their reliability and their conclusions. They may be coloured, either positively or negatively, by the specific interests of the agencies who commissioned them, depending on their point of view. In between, lie many analyses which strain for objectivity but are hampered by the lack of solid empirical evidence….
>
> An even greater confusion exists in the EU [than in the United States] where there are notably few academic, systematically led investigations in the area of European and offshore outsourcing. Estimates of the impact on Europe are vague, especially in relation to outsourcing to smaller Asian countries and eastern European states. (Huws et. al. 2004, p. 10)

Table 2 provides an overview of some of the consultant data on the extent and impact of offshoring in Europe. The amount of offshoring is clearly at substantially lower levels than in the United States. These reports indicate that only about 5% of European businesses are currently offshoring, and not quite a third of European companies are even planning for offshoring. Huws et. al. (2004) point out that most studies agree that 2 to 3% of all EU service employment will be lost to offshoring by 2015 but notes that this loss is likely to be less than the number of new jobs created so that the European service industry is likely to expand its employment over time.

It is true today that Europe overall is not losing IT service jobs. Even at the country level, this is mostly true, and where there are national losses, in every country other than Denmark, any losses in computer jobs have been more than offset by growth in business service jobs (Eurostat, Community Labour Force Survey). Other than the United Kingdom, Western Europe has a decided preference for selecting Eastern European firms to do their offshore work (Pierre Audoin Consultants (2003), quoted in Huws et. al. 2004). Nevertheless, there is a sizable amount of work sent from Germany as well as from the United Kingdom to India. Eurostat data (Community Labour Force Survey) shows that the EU countries that are growing most rapidly in IT business activities are the new member states such as Hungary which had been behind the rest of the EU in percentage of IT activities. These data are consistent with, but not proof of, these countries becoming prime destinations for European offshoring.

Table 2-2: The Extent and Impact of Offshoring on Europe

Forrester (August 2004 as quoted in Gumbel 2004 and Knapp 2004)	Jobs lost by Europe to offshoring by 2015	1.2 million, including 150,000 IT jobs
Deloitte Research (quoted in Matlack et al. 2004)	Financial-services and high-tech jobs that will migrate from Europe to low-wage countries by 2008	800,000
Heidrick and Struggles/PeopleSoft (2004) as reported in van Breek (2004)	CEOs of European companies who reported offshoring work to low-cost labor markets as a key business issue	31%
European Commission 2000 (as quoted in Huws et al. 2004)	European companies offshoring	5.3%
Forrester Research (as quoted in Huws et al. 2004)	Value of offshore spending in western Europe in 2004 and 2009	1.1 billion, 3.6 billion Euros
Gartner (as quoted in Huws et al. 2004)	European business expected to include offshoring in their business plans by end of 2005	30%
Huws et al. (2004)	EU service employment lost to offshoring by 2015	2% to 3%

United Kingdom

The United Kingdom is the largest offshorer in Europe by a considerable margin, and this trend is likely to continue at least for the next few years. Forrester Research estimates that the United Kingdom will be responsible for three-quarters of all European offshoring in five years (Huws et. al. 2004). 61% of UK companies send IT work across national boundaries compared to only 15% in Germany, the second largest offshorer in Europe (Roland Berger 2004). Amicus (2004) claims that a thousand UK jobs are being lost to offshoring each week and projects a loss of 200,000 UK IT jobs by 2008 with a significant number of these positions in IT support.[BSB5] Management Consultancies Association predicts 25% growth in offshoring of call centers between 2003 and 2008 (Huws et. al. 2004). The Communications Workers Union (2004) predicts almost 200,000 call center jobs moved from the United Kingdom to low-cost countries between 2004 and 2006.

According to the consulting firm Evalueserve (2004), the United Kingdom will face a shortage of 714,000 workers by 2010 due to the aging of the workforce. IT is one of the fields projected to have the greatest shortages. Evalueserve estimates that 342,000 of these 714,000 jobs can be filled by immigrants and notes that the remainder will need to be filled in other ways if the country is to avoid a decline in GDP due to an insufficient labor pool. Evalueserve claims that, by the end of 2002, 31,100 jobs in the service sector in the United Kingdom had been moved offshore, and the company projects that 272,000 more jobs will move offshore in the period 2003-2010. Focusing more narrowly on IT and software development jobs only, Evalueserve claims that 18,000 jobs had been moved offshore by the end of 2002 and 84,000 more would be moved between 2003 and 2010.

GERMANY

In Germany, there are no federal statistics that help to track the number of jobs offshored (Bartsch 2004). For various reasons, it is expected that offshoring will not be as significant in Germany as in the United States: few people in low-wage countries speak German, Germany has fewer low-skill jobs than the United States of the sort that have been offshored, stricter layoff regulations make it more costly in Germany than in the United States to lay off workers and relocate the work overseas, and there has been less political fallout over jobless recovery after the last recession than in the United States. Germany historically does not have such strong labor rebounds after a recession as the United States. After the most recent recession, job recovery was close to the historical norms in Germany, while in the United States the recovery led to an unprecedented small number of jobs created.

Using an analysis of German foreign direct investment in Central and Eastern Europe by the Oesteuropa-Institut, together with employment trends in German foreign affiliates and correction factors for the German foreign affiliates numbers (because they underreport activities by small and medium-sized companies), Elga Bartsch arrived at an estimate on behalf of the consulting firm Morgan Stanley that the number of jobs (of all kinds) offshored to Central and Eastern Europe over the past decade is approximately 600,000. She also considered an alternate source, the European Restructuring Monitor (ERM), which "compiles information on major corporate restructuring announcements from daily press runs of the major national newspapers in the European Union and classifies them by country, industry, and reason for the restructuring" (Bartsch 2004). The ERM found that 117,000 jobs losses were announced in Germany from January 2002 into mid-2004, and that 3% were lost to relocation of production facilities and another 0.3% to outsourcing. In another study commissioned by the Deutsche Bank, it was estimated that 50,000 German IT-related jobs had been relocated outside Germany up until the time of the publication of the study (Huws and Flecker 2004).

In a McKinsey study (Farrell 2004), Germany shows only a $0.80 return on each dollar invested in offshoring, compared to $1.14 return on the dollar invested in offshoring for the United States. There are multiple reasons for this: German companies have higher management costs because of language and cultural issues; offshoring work is frequently contracted to Eastern Europe where the wages and infrastructure costs are higher than in India; Germany is not able to capture much in high-tech exports through offshoring because of the dominance of US firms in these export markets; Germany gains practically nothing from repatriated earnings (i.e., from offshoring providers abroad that German companies have invested in); and most important of all, as many as 60% of German workers have difficulty being re-employed when they lose their jobs through offshoring which is a major drag on the German economy.

What Does the Data Tell Us About the Size and Impact of Offshoring in India?

By far, the most complete data about the Indian software industry is provided by the Indian trade association, NASSCOM. Table 3 provides a snapshot of the offshore industry based on the NASSCOM Strategic Review 2005. You can see that the industry is vibrant with growth in the 20 to 30 percent range each year. IT software and services are still the largest export, far ahead of hardware and ITES/BPO, but the IT-enabled services are growing more rapidly than any other sector of the Indian offshoring industry. The United States, followed distantly by the United Kingdom, is the destination of most of this work.[3] About 60% of the ITES/BPO work is conducted by multinationals with this percentage edging higher over time. The export trade is growing much more rapidly than the domestic IT/ITES market in India, from 58% to 78% by revenue from 1996 to 2003 (RIS 2004 as quoted in UNCTAD 2004). The software and service industry is becoming increasingly important to India's economy, growing from 3% to 21% of India's total exports between 1996 and 2003 (RIS 2004 as quoted in UNCTAD 2004). Although there are more than 3000 software and service exporters in India, 25 of these firms collect more than 60% of the revenue (Prism 2004).

Table 2-3: The Extent and Impact of Offshoring in India

Indian national economic output attributable to the IT-ITES industry in 1997-98	1.2%
Indian national economic output attributable to the IT-ITES industry in 2003-04	3.5%
Indian IT industry revenue in IT services and software in 2003-04	60%
Indian IT industry in hardware in 2003-04	22%
Indian IT industry in ITES/BPO in 2003-04	18%
Growth in Indian IT and ITES exports	$9.9 billion in 2002-03 $$13.3 billion in 2003-04
IT and ITES export from India to the United States in 2003-04	69%
IT and ITES export from India to Europe in 2003-04	22% (mostly to the United Kingdom)
India IT services and software revenue in 2003-04	$12.8 billion (29.6% increase over previous year)
Jobs added to Indian IT services and software sector in 2003-04	98,000 (more to domestic companies than multinationals)
Growth in Indian IT services revenue	$1.9 billion in 2002-03 $2.5 billion in 2003-04
Growth in Indian offshore product development exports (includes exports of software products made by Indian companies)	$560 million in 2002-03 $710 million in 2003-04 (mostly produced by multinational captives)
Multinational companies that opened captive centers in India since early 2001	230

[3] Joseph and Parayil (2004 as quoted in UNCTAD 2004) claims 80%. Table 3 gives 69% for IT and ITES combined.

Value of research conducted by Indian captives of multinationals in 2003-04	$800 million to $1 billion
Value of research conducted by Indian captives of multinationals in 2008 (projected)	$11 billion
Call center seats	96,000 in 2003; 158,000 in 2004

Source: NASSCOM Strategic Review 2005

What Does the Data Tell Us About the Size and Impact of Offshoring in Countries Other Than India That Do Software Work for Export?

Quantitative information about software exports especially those related to offshoring is difficult to locate for most countries. Table 4 provides a smattering of data that we have been able to locate although we cannot attest to its correctness.

Table 2-4: Nations Other than India with Offshoring Industries

Country	**Statistic**	**Source**
Australia	$21B commercial service exports in 2003 (22% computer and communications)	World Development Index database
	call center seats: 135,000 in 2003, 146,000 in 2004	www.bpoindria.org/knowledgeBase/
Barbados	$1.1B commercial service exports in 2003 (16% computer and communications)	World Development Index database
Belarus	$1.5B commercial service exports in 2003 (24% computer and communications)	World Development Index database
Brazil	$9.6B commercial service exports in 2003 (50% computer and communications)	World Development Index database
Canada	HRDC estimates 500,000 Canadians work in call centers	Prism (2004)
Cape Verde Islands	$211M commercial service exports in 2003 (9% computer and communications)	World Development Index database
China	8,000 software and service providers, _ of whom have fewer than 50 employees and only five have more than 2,000 employees. (Yuan 2005)	McKinsey (January 2005)

	$1.5B in 2003	Prism (2004)
	Call center seats: 38,000 in 2003; 54,000 in 2004	www.bpoindria.org/knowledgeBase/
Czech Republic	$7.8B commercial service exports in 2003 (24% computer and communications)	World Development Index database
Dominican Republic	$3.4B commercial service exports in 2003 (5% computer and communications)	World Development Index database
Ghana	$612M commercial service exports in 2003 (11% computer and communications)	World Development Index database
Guatemala	$954M commercial service exports in 2003 (19% computer and communications)	World Development Index database
Hong Kong	Call center seats: 10,000 in 2003; 10,700 in 2004	www.bpoindria.org/knowledgeBase/
Hungary	$7.9B commercial service exports in 2003 (41% computer and communications)	World Development Index database
Ireland	leads the global market in offshore IT services with 25% of market	World Investment Report 2004
	$3.8B in 2000, 8.5B Euros in 2003	Prism
	60% of EU software is developed or localized in Ireland; software industry is 11% of GDP	
	55% of Ireland's 28,000 IT professionals are employed by multinationals and account for 90% of Irish software exports	
	$38B commercial service exports in 2003 (61% computer and communications)	World Development Index database
Israel	$1.9B value in offshoring exports in 2002	Prism (2004)

Latvia	$1.5B commercial service exports in 2003 (19% in computer and communications)	World Development Index database
Madagascar	$202M commercial service exports in 2003 (32% computer and communications)	World Development Index database
Malaysia	call centers growing at between 100 and 200% per year since 2000	World Investment Report 2004
	$14B commercial service exports in 2003 (33% computer and communications)	World Development Index database
Mauritius	$1.3B commercial service exports in 2003 (17% computer and communications)	World Development Index database
Mexico	$13B commercial service exports in 2003 (7% computer and communications)	World Development Index database
Morocco	$5.1B commercial service exports in 2003 (18% computer and communications)	World Development Index database
	Call center seats in all North Africa in 2005 (Morocco has largest share): 3,900	Datamonitor
New Zealand	Call center seats: 12,000 in 2003; 13,500 in 2004	www.bpoindria.org/knowledgeBase/
Philippines	27,000 people in call center jobs in 2003 and growing rapidly	World Investment Report 2004
	$250 software, or $1B including BPO (2003)	Prism (2004)
	Call center seats: 20,000 in 2003; 40,000 in 2004	www.bpoindria.org/knowledgeBase/
Poland	number of jobs in BPO will increase from 3,000 in 2004 to 200,000 in 2008	McKinsey & Co. (as quoted in Wagstyl 2004)
Romania	$3B commercial service exports in 2003 (42% computer and communications)	World Development Index database

Russia	$150 – 200M value of offshoring exportsin 2003	Prism (2004)
Senegal	$3890M commercial service exports in 2002 (40% computer and communications)	World Development Index database
Singapore	Call center seats: 10,000 in 2003; 10,100 in 2004	www.bpoindria.org/knowledgeBase/
Slovak Republic	$3.3B commercial service exports in 2003 (28% computer and communications)	World Development Index database
South Africa	number of call centers to expand from 494 in 2004 to 939 in 2008); serving the English but also the German populations.	Datamonitor (as quoted in Chatterjee 2004)
	Employees working in call centers in 2005	New York Times (Feb 2, 2005)
	$6.4B commercial service export in 2003 (9% computer and communications)	World Development Index database
Thailand	Call center seats: 11,000 in 2003; 13,000 in 2004	www.bpoindria.org/knowledgeBase/
Tunisia	$2.8B commercial service exports in 2003 (16% computer and communications)	World Development Index database
Ukraine	$5B commercial service exports in 2003 (11% computer and communications)	World Development Index database

2.3 Conclusions

Even in the face of offshoring, economists generally continue to believe in the theory of comparative advantage, that if each country specializes in the production of goods where it has comparative advantage and trade is not restricted, both countries can enjoy greater total consumption and well being by trading with one another. Some economists, notably Gomory and Baumol, have pointed out that it is possible for a country to lose under free trade. In the short-term, the question is one of jobs and wages. Are the jobs lost to offshoring in developed countries compensated for by new job creation in these countries which might come, for example, from the lower cost of development and production, faster development time, higher quality, or round-the-clock service associated with using an offshore workforce to supplement or supplant the domestic workforce? Similar questions can be asked about wage rates. The analysis by Mann of hardware offshoring to Asia in the 1990s suggests by analogy that it is entirely possible for a developed nation to be much better off through offshoring of its software work. Recent Bureau of Labor Statistics shows that IT jobs and wages have generally increased in the United States from the height of the dot-com boom until late 2003, a period during which there was active offshoring. However, lack of data limits what we can say about the impact of offshoring.

Leaving aside for the moment the question of whether offshoring has hurt aggregate jobs or wages, there are at least two ways in which offshoring might harm a developed country. Offshoring clearly can do harm to individuals who lose their jobs through offhsoring and to local communities that lose large numbers of jobs or particular businesses through this type of trade. The general sense among economists is that the only solution to this is a political one of providing a safety net to workers. This might include wage insurance, extended unemployment benefits, retraining, and perhaps others benefits. However, the costs of providing this safety net are great. The other way that offshoring can harm a developed country in the long run is to erode the country’s capability to innovate. As a developed country loses its edge in innovation, it becomes less able to remain competitive. Enabling a country to remain innovative is a matter of education, research funding, and immigration policy. These issues are discussed in Chapters 7 and 8.

What does the available data tell us about the extent and trajectories of offshoring? First, considering the United States which has seen the largest amount of offshoring and is subject to the greatest amount of loss through offshoring, we know that there are perhaps 12 to 14 million jobs vulnerable to offshoring. However, this number represents a high upper bound on potential job losses, and nobody believes that all these jobs will be lost. So far, annual job losses have probably been no more than 2 to 3% of the IT workforce in the United States. Moreover, there are questions about the reliability of these numbers because of the definitions and other methodological issues. The meaningfulness is also at question because these job losses have to be placed in perspective with the much higher level of job loss and creation that occurs every year in the United States and, in particular, with the jobs that are created directly or indirectly because of companies sending work offshore. The data simply does not exist that would enable a full analysis of the impact of offshoring on the US IT workforce. Anecdotal information, together with data, suggest that the United States will continue to increase the amount of work it offshores at double-digit percentage rates at least for the next few years. Programming and related technical work continues to be the work most likely to be offshored, but IT-enabled services are rapidly taking a greater share. There is also rapid growth, from a small base, in the offshoring of higher-value activities such as knowledge processing and research.

Data about countries other than the United States or worldwide data are much harder to come by than data for the United States. There are reports of offshoring industries or sectors of these industries that have grown in India, China, and a few other countries by 20, 30, or higher percentages per year with projections that these growth rates will continue for varying lengths of time into the future. It is difficult to evaluate these projections but it seems likely that there will be continued rapid growth at least for the next few years. Whether these growth rates will be 10, 20, 30, or 40 percent per year is beyond our ability to project based on existing data. It appears that India will continue to be the primary destination of offshoring, with China growing rapidly. However, Chinese software activities are devoted to a significant extent on the emerging domestic market not the export market. There appears to be some promise of growth for the main nearsourcing countries such as Canada and those in Eastern Europe despite the fact that their wage rates are higher than those in the low-wage Asian countries. There are at least limited opportunities for offshoring work by companies located in Africa, Latin America, and low-wage Asian countries other than India and China. Data, together with anecdotal evidence, suggests that Western Europe is beginning to increase the amount of work it offshores. The United Kingdom has been by far the largest offshorer in Europe, and this is likely to continue to be true for the next few years. And Germany, in particular, has begun to increase the amount of work being offshored in the past year or two. Japan is set to increase the amount of work offshored especially to China.

There are numerous problems with the current state of data. Definitions used in reporting offshoring's growth and impact are inconsistent with one another. All of the obvious metrics that could be used to measure offshoring have limitations. Government statistical organizations, such as the US Bureau of Labor Statistics and the Bureau of Economic Analysis, provide the greatest promise in providing good data because of their highly trained staffs and long traditions of quality, reliability, and objectivity. Governments collect data, however, in connection with existing policy issues, and the offshoring phenomena is sufficiently different that existing government data sources turn out to be not very useful. Trade organizations and consulting firms are not disinterested parties, and these organizations are often unwilling to make public the methods and assumptions by which they arrive at their results so it is not surprising that there is some skepticism in the economic community about the credibility of their results. For many parts of the world, little or no data is being gathered.

A professional society such as ACM itself is not in a good position to collect data. However, it can encourage the principal data gatherers – governments, trade associations, and consultants – to improve their offshoring data practices. We need clear definitions, careful choice of metrics, data that separates the impact of offshoring on job loss from other causes of job loss such as business cycles and technological change, and data that measures the various aspects of offshoring (jobs created, gains in wealth to companies and nations, impact on wage rates, etc.) not just job loss.   Thus, we recommend that the following steps be taken:

Standard definitions of offshoring and related terms should be developed. A good starting place is the diagram developed by the US General Accountability Office (Figure 2) that provides a complete description of all outsourcing and offshoring activities. These definitions should be used by all countries participating in the global software market, not just the United States.

The US Department of Labor should gather data on layoffs that is more suited to measuring offshoring than the current Mass Layoffs Statistics data. Ideally, such data should be collected on a regular basis, but even a one-time special effort would be useful. Other countries should collect similar data.

The United States should improve the collection of data on imports and exports of services by country, following the guidelines recommended by the General Accounting Office (2004). Other countries should follow similar practices, and practices should be consistent from country to country.

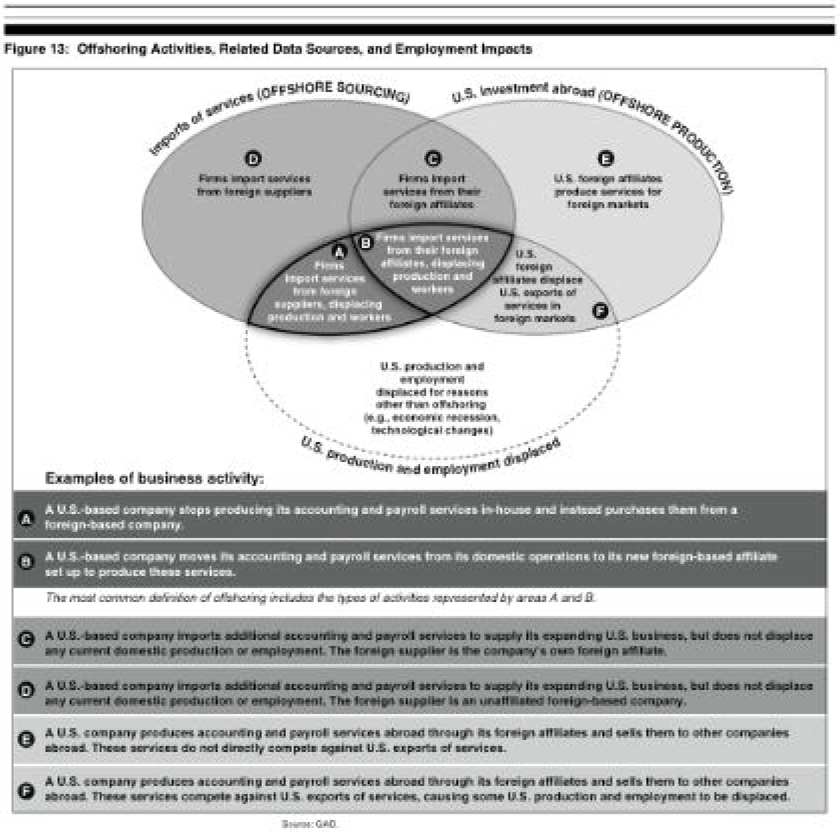
Data on direct investment abroad by source country and multinational company operations should be improved also following the recommendations of the GAO (2004).

R&D and design activities in low-wage countries should be tracked especially in affiliates of multinational firms.

All organizations, private as well as public, that are creating statistical information about offshoring should be transparent about their methods and assumptions.

Developing better current data and adopting standardized definitions should help to improve projections of offshoring. We are not sanguine, however, about the likelihood of developing good projections any time soon. In the United States, the BLS has been modestly successful in developing ten-year occupational projections, but projecting the size and effects of offshoring appears to be more difficult.

Figure 2-2



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Although their software export markets are significant, they are relatively small and are not expected to grow much especially in comparison, for instance, to India or China. Ireland and Israel also do not appear to have a major effect on the global division of software labor.

We also omit many nations that have smaller software services export businesses such as the Philippines and Mexico. Mexico, which in 2003 is estimated to have exported $30 million of software and software services (Singh 2003), is discussed in Chapter 4 through an examination of one of its leading software export firms, Softtek. Mexico's limited amount of software services exports is typical of many developing nations. Rather than listing all of the nations and the size of their industries (see some data on this topic in Chapter 2), this chapter focuses on the most important ones, but suggests that they are not unusual, just indicative of the larger pattern of globalization.

Offshoring has a long history and continues to evolve. National IT industries and international supplier-customer relationships are part of a co-evolutionary process involving many parties. Factors include government support, education, infrastructure, telecommunications policy, finance, and even national perceptions. These factors interact and gradually produce an environment more or less favorable to accepting relocated work. This is exemplified in the case of China and its manufacturing sector where a sophisticated manufacturing support infrastructure evolved over the past two decades to facilitate the manufacturing of goods for export. In the case of India, higher educational institutions, infrastructure, labor force, and government policies have evolved in a way that encourage and support the production of IT services for the global economy. Each of the nations and international relationships examined in this section is a product of similar co-evolution.

For firms, the decision of whether and where to offshore a certain business function involves a complex calculation that balances a variety of concerns that include labor force availability, government policy, factor costs, various kinds of risk, and comfort level with the location. For each of these nations, this chapter examines both their past experiences with offshoring and their current situation. We also consider their prospects for future growth.

3.2 The History of Software Offshoring

The origins of software offshoring are difficult to determine because large multinationals such as IBM have long had overseas R&D facilities that were conducting software development for the company's global operations at the same time that they were undertaking localization work for their domestic markets. The nations that first emerged as software development sites for the global economy, that is, not for the domestic market, were Israel and Ireland. Notice the distinction made here between undertaking software development for the domestic market, which includes localization and even some development based on unique features of the local market such as different accounting or legal systems, as opposed to producing for the external market. Production for the local market can displace jobs for workers in high-wage countries. However, it is unremarkable that localization would be undertaken in the local market where knowledge of the language and the specifics of the business culture and legal environment are the greatest. With respect to job loss, there is far greater concern about the displacement of labor by a nation producing for another nation's market than for its own.

The United States is the overwhelming leader in the world software industry as the home to such firms as Accenture, IBM, Microsoft, and Oracle. The only firms that rival these giants are SAP (headquartered in Germany) in packaged software and Siemens Business Systems (Germany) and Cap Gemini (France) in software services. Siemens Business Systems is losing money and may be sold.

Let us turn briefly to the small economies, Ireland and Israel, which pioneered software and software services production for the global economy. The Israeli IT industry first emerged in the late 1960s through an excellent educational system, military research, a strong relationship to the United States based on geopolitics, and investment by multinationals (de Fontenay and Carmel 2004). In the 1980s, Israelis began to found new technology firms, many of which specialized in packaged software especially for security. These Israeli firms often had cutting-edge technologies and, as part of their life cycle, very soon established operations in the United States. The most successful of them listed their stock on NASDAQ. Many of these firms were successful, but because of the small size of the Israeli software industry their success is unlikely to lead to a massive relocation of employment from the developed nations to Israel. The total Israeli employment in IT services, including software, was 92,000 in 2000 or approximately 4 percent of the total Israeli workforce (de Fontenay and Carmel 2004, 43). The Israeli Export and International Cooperation Institute (2005) reports Israel as having 13,000 software professionals in 2002, down from an all-time high of 14,500 in 2000. Whichever number is correct, Israel has a much smaller software workforce than larger nations, though it is unusually large in terms of the percentage of its own population. Even if Israel were to double its IT services employment to an unheard of 8 percent of its workforce – amounting to some 200,000 employees – it would still be less than one-third the size of India's 697,000 employees in software and software-related services. Israel's niche in the global software industry is as a center of entrepreneurship at the highest technological level. It draws upon the technical expertise of a highly trained workforce, and its startups almost immediately enter the US market by forming an offshore office.

Another early location for software offshoring was Ireland. In the 1990s, both Irish indigenous firms and multinationals rapidly increased their software-related activities in Ireland. For the multinationals, Ireland was a convenient low-cost, English-speaking nation that had strong European language skills. The multinationals adopted Ireland as an offshore platform for Europe. In 2000, the total number of employees in the Irish software and computer services firms, counting both indigenous and multinational firms, was 30,000 (Arora et. al. 2004). It is difficult to fully reconcile the various statistics as O'Riain (2004) believes that in 1999 there were over 50,000 employed in the software industry. The larger number may be misleading because O'Riain finds that the multinational firms that make up approximately two-thirds of total software industry employment include among their activities disk reproduction, packaging, language localization for Europe, and porting (O'Riain 2004).

Ireland's software industry includes two kinds of companies. There are some indigenous firms that produce packaged products, although they have not been as successful as the strongest Israeli firms. Ireland is also a packaging and localization platform for foreign, particularly US, multinationals supplying the European market. Ireland has experienced robust growth in its software industry but, like Israel, the global impact has been limited. Recently, the Irish press has expressed concern that India might be a threat to the growth of the employment in the Irish software industry (Weckler 2004).

Israel and Ireland were pioneers in entering the global software business without a significant home market. Israel's entry was at the high end of the industry, both in terms of multinationals operating there and the local entrepreneurship. Because Israeli firms quickly built strong business units in the United States, they are often treated as being the same as US firms. In fact, the growth of a successful Israeli firm often occurs as much in the United States as in Israel. In the Irish software industry, startups have produced software for the world market but they typically remain small players, while multinationals located there are fixed on one aspect of the global market, meeting the multinational's localization needs for the European market. The software industry is a significant economic contributor to Ireland even though it remains quite small in global terms.

Due to their small size and strong relationships with the rest of the developed world, the Israeli and Irish software industries were successful without disrupting the software industries in other nations. Wages in Israel and Ireland were slightly lower than the markets they serviced, primarily the United States and Europe. Israel competed not on cost, but instead on the high quality of its workforce. Ireland had a wage advantage and special subsidies from the European Union but operated on only a small scale. What these two countries showed was that a nation that did not have a large local market could nevertheless perform software work at a distance from the final market if it had a skilled workforce and access to good telecommunications infrastructure.

The next set of entrants could disrupt existing software industries. The largest and most sophisticated of these national entrants was India. By the late 1990s, software programming was no longer a skill that was highly concentrated in the developing nations. People in low-income nations could afford an increasingly powerful personal computer and had access to inexpensive, high-capacity data communications networks. Not surprisingly, these countries could and did begin offering programming services in the global economy.

Today, it is possible to benefit from labor cost savings for programming services from a large number of developing nations. Although the pattern is peppered with many exceptions, there is a global division of labor emerging with India serving the English-language market, Eastern Europe and Russia serving Western Europe, and China serving Japan. Developing nations around the world have been eager to capture the wealth and jobs associated with software offshoring.

From the inception of the computer industry in the 1950s, the United States was not only the leading center for software but also defined the global software environment because of its technology leadership, enormous market, and massive investment in IT R&D. Other national markets were, for all intents and purposes, local markets having their own software firms that were always under threat from being submerged by global firms. If local firms wanted to expand significantly, then the US market was critical to their success. This was something the Israeli firms understood from their inception. For this reason, the first two nations to be discussed are the United States and its principal offshoring destination, India.

3.3 The United States

US-based companies continue to dominate the software and services industry. Of the roughly $285 billion in total revenues of the global industry in 2004, only about $50 billion was generated by non-US companies.[1] [2]

History of the US Software and Software Services Industry

From the inception of the modern computer industry, the United States has been the leader in both the hardware and software industries. The United States has also been the source of many of the software standards such as Windows, Microsoft Office, and Unix,

[1] This was calculated from the 2004 SoftwareMag.com *Global Software 500* ranking.

[2] This accounts for only the traded software and software services. So, for example, if a firm writes software internally for only Internal use, then this is not included because it is untraded. This is an enormous category and is likely to be even greater than the amount traded. Chapter 4 examines firms that have large internal software operations whose work is being offshored even though it is not traded.

providing US firms with an important first-mover advantage.[3] Although today some might dispute US leadership in hardware due to the growth of East Asian producers, few would dispute US leadership in software and software services. Software and software services as an independent business has been practiced in the United States for more than fifty years, since the founding of the computer services firm Automatic Data Processing (ADP) in 1949. Computer Usage Corporation (CUC), founded in 1955, was the first company formed specifically to provide software development services to computer users. Its first project was a program written for a customer to simulate the flow of oil. Computer Sciences Corporation (CSC), founded in 1959, is now a $10 billion company. EDS, one of the most important computer services firms, was founded in 1962. Since then, thousands of companies that provide software and software services have been formed.

The growth of independent software and services firms was assisted by the decision by IBM in 1969 to unbundle its application software and tools from its hardware. IBM did not unbundle its operating systems from the hardware; the control system was included in every product IBM sold for many years after 1969. By 1969, there were already approximately 2,800 independent software product and services firms, and they had combined revenue of $600 million (Steinmueller 1996). At the same time the software and software services industry was emerging, large firms, especially in the financial and defense sectors of the economy, were introducing computers into their operations and building internal software competencies. For most firms, the building of internal IT expertise was both a potential competitive advantage and a necessity because computers were becoming key devices for managing the increasingly complex corporate operations they made possible. By the end of the 1960s, the combination of government funding of engineering and computer science research in the open university environment, early adoption by sophisticated lead users, and the United States' role as the largest economy and market in the world meant that the United States gained what appeared to be an insurmountable lead in the software arena.

The US software and services industry was affected by other developments as well. Drops in prices of semiconductors and data storage, driven in part by Moore's law, led to continuous price-performance increases in computers. The big mainframe of the 1960s was complemented by the arrival of the minicomputer in the 1970s and the personal computer in the early 1980s. The PC drove the cost of a computer down to a level that permitted an installed base of millions of computers, not the hundreds of computers of the 1950s or the thousands of the 1960s. This growth in the installed base was accompanied by a huge growth in the demand for packaged software for these computers. The early independent software companies developed applications and later computer tools. Originally the operating system software was provided by the hardware vendors (IBM, Digital Equipment, and others), but in recent years, independent software houses have emerged that also develop operating systems. (For a discussion, see Baldwin and Clark 2000).

The introduction of a commoditized personal computer in the 1980s and the spread of the Internet in the mid-1990s led to the creation of many new US companies, not only companies such as Netscape, providing software to facilitate the use of the Internet, but also the service and shopping companies such as Yahoo! and Priceline.com. The market leaders, for instance, Google, Yahoo, Amazon, and eBay, weathered the dot-com stock collapse beginning in 2000, and, in the process, they have transformed the way business is conducted.

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[3] It is possible that the relative strength of US firms might eventually be eroded by widespread adoption of open source software.

US firms benefited the most from the new business models and software that drove the Internet, and these firms continue to be globally dominant. They were created from the research and private sector capabilities that were uniquely resident in the United States (Kenney 2003). The dot-com crash led to severe employment loss in the IT/software sector. It was also a watershed event for the global software industry. During the height of the boom, US companies could not find enough US workers and sought extra capacity from overseas, especially Indian workers (both imported to work in the United States and working in India). After the crash, the role of the Indian workers was more as a replacement than a supplement to US workers. The Internet has also contributed to creating a more global labor market, making it easier to access technical talent in any location with good telecommunications linkages.

The Current Situation for US Companies in Software and Services

As mentioned earlier, US firms receive about 80% of the revenue available in software and services. Of the top fifteen firms in this industry, only four – SAP (Germany), Hitachi (Japan), CapGemini (France), and NTT (Japan) - are not from the United States, and these firms occupy the bottom rungs of the top 15.

In 2004, US firms made up 16 of the top 20 packaged software firms when measured by revenue. All of these firms have factories, development labs, and sales scattered across the globe. But where is the employment? Of the approximately 595,000 workers in packaged software, the United States employs 50 percent of the total global employment, while US firms sell 84 percent of the packaged software purchased globally (McKinsey Global Institute 2005).

US firms have been remarkably successful. For example, Microsoft's fiscal year 2005 profits of over $12 billion were comparable to the $12 billion in fiscal year 2005 revenue of the entire Indian software and services export industry. Microsoft's profit was also approximately equal to the sales of the largest European firm, SAP. IBM's software and services revenues in 2004 were in excess of $61 billion. The point is that US packaged software firms, by any measure, are still globally dominant. In terms of influence, the importance of this dominance is even greater than simply sales; the United States is the global hotspot for packaged software.

The McKinsey Global Institute (2005) reports that US jobs in the packaged software industry are at risk of being offshored. McKinsey finds that 60 to 78 percent of the jobs at risk are professional engineers and associated middle-level managers, that is, the heart of the packaged software industry. Other occupational groups in the packaged software industry have lesser but very significant numbers of jobs at risk. As shown in Table 2, it is exactly in the more highly educated employment categories that US firms are recruiting actively in India and, to a lesser degree, in China. Notice that the position announcements are not confined to low-end college graduates but also include doctoral-level positions for sophisticated development projects. The beginnings of this process can be seen in Table 1 which shows the number of employees the software and software services firms currently have in India. In every case, these numbers are increasing at double-digit rates.

Table 3-1: Indian Employment by Non-Indian Software and Software Services Firms

	Nationality	Services only	Employment in India (date)	Global Employment*	% in India	Locations
Oracle	U.S.		6,900 (2004)	41,658	16.6	Bangalore, Hyderabad
Microsoft	U.S.		1,250 (2004)	57,000	2.2	Bangalore, Hyderabad
SAP	Germany		2,000 (2005)	38,802	5.2	Bangalore
IBM[4]	U.S.		23,000 (2005)	369,277	6.2	Bangalore, Delhi**, Kolkota, Pune, Hyderabad
HP	U.S.	Yes	15,000 (2004)	150,000	10	Bangalore
Veritas	U.S.		900 (2004)	17,250	5.2	Pune
Adobe	U.S.		500 (2005)	3,142	15.9	Delhi
Symantec	U.S.		0 (2005)	5,300	0	n/a
EDS	U.S.	Yes	2,400 (2004)	117,000	2.1	Chennai, Delhi, Mumbai, Pune
Dassault Sys	France		0	4,088	0	n/a
Cap Gemini	France	Yes	2,000 (2004)	59,324	3.4	Mumbai, Bangalore
Siemens Bus Sys	Germany	Yes	4,000 (2004)	36,000	11.1	Bangalore
Getronics	Netherlands	Yes	n/a	28,000		
Atos-Origin	France	Yes	750 (2004)	46,583	1.5	Mumbai
Tietoenator	Finland	Yes	120 (2005)	14,000	.9	Pune

** Hoover's 2004*

***Delhi includes Noida and Gurgaon which are suburbs in other states*

All bolded firms include large non-software based employment
Source: Internet searches

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[4] This includes the 6,000 BPO employees when IBM acquired Daksh and also includes those working for the domestic market.

The United States leads in software services as well as in packaged software, and this lead in services is also attributable in part to the early software development in the United States. The United States is the largest single software services market in the world, accounting for approximately 41 percent ($198.6 billion) of a total 2004 global market of $484.3 billion (McKinsey Global Institute 2005). US vendors are the global leaders in the global software services industry (11 of the Top 20 globally are headquartered in the United States) with IBM Global Services at 2004 sales of $46 billion by far the largest. Software services employment in the United States is approximately 1.7 million, of which 42 percent are engineers (McKinsey Global Institute 2005). In other words, software services is a large industry and the United States supplies about 32 percent of the total global workforce (McKinsey Global Institute 2005: 158).

The occupational categories in IT services that McKinsey finds most amenable to offshoring are software and hardware engineers and associated middle-level managers, of which 47 to 56 percent could be offshored. Analysts working on software/IT architecture or market research are similarly vulnerable (45 to 55 percent). It is in software services where the most aggressive competition from Indian vendors is to be found, and where the US leaders, such as IBM, Accenture, and Hewlett Packard, are rapidly increasing their offshore and particularly Indian presence.

One can expect the number of available jobs, job tenure, and wages throughout the software and service-related industries to be pressured by offshoring during the next decade. This pressure will also be felt in the internal IT shops across all industries as management considers options ranging from establishing offshore subsidiaries to outsourcing the work to either a US firm operating abroad or an Indian firm. Routine software production and services work appears to be increasingly susceptible to offshoring.

Conclusion on the United States

During the past five decades the dominance of the US industry has been a given. What is changing is where the work will be undertaken. What has been an enormous export to the world and a well-paid source of employment for technically well-trained Americans is now in question as sufficiently well-trained individuals in much lower-wage nations are becoming participants in the global economy and will be competing for those jobs. As Chapter 7 on education discusses in greater detail, the US higher education system will have to address the question of what their students should learn to prepare for these changes. At the national level, there has been a dramatic underinvestment in engineering education and research over the last two decades,[5] and the recent decisions by the federal government to reallocate research funds from universities to industry will further weaken engineering. This is likely to contribute to an erosion of the cutting-edge research that makes the United States a desirable place to undertake software innovation and development and which has made the US high-technology industry a global leader.

3.4 India[6]

Software services have become India's largest export, and the emergence of India as a source of software service exports is attracting great attention in the developed world. India has only recently attracted attention for its software service exports despite the fact that

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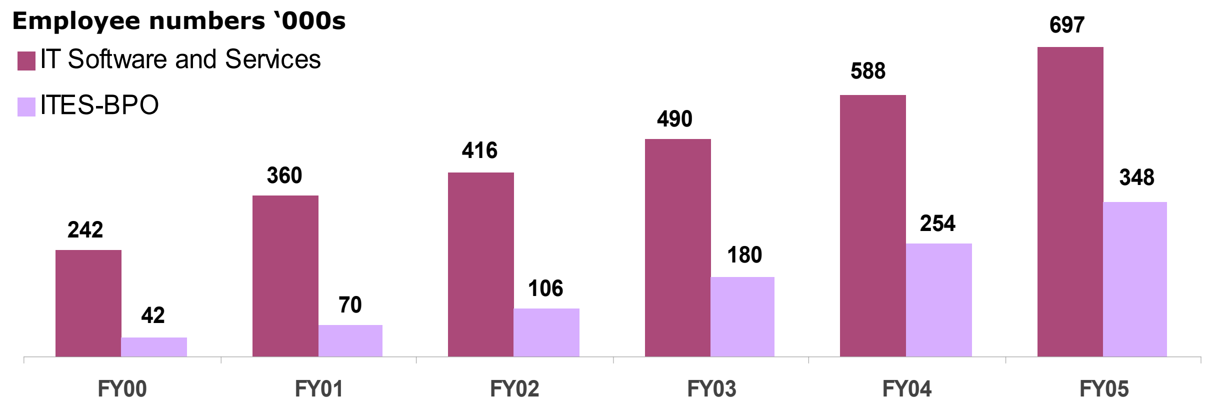
[5] For example, since 1970, U.S. federal spending in physical science research declined as a percentage of Gross Domestic Product - an indicator as the rate of investment relative to
growth in the economy - from just under 1% of GPD to .5% in 2004.
Source: http://www.aaas.org/spp/rd/disc04tb.pdf

[6] This section draws heavily upon Dossani (forthcoming 2006).

the industry has grown relatively steadily for three decades. Employment reached 697,000 (approximately 50% working for the domestic market) at the end of March 2005 (see Figure 2), a growth of 19.8 percent from the year earlier (Nasscom 2005). If the industry grows at 20 percent per year in 2005-2006, then the number of employees added in India would be the equivalent of all the software workers in Ireland and Israel combined. India is emerging as the single most important destination of software services offshoring.

Figure 3-2: Employment in the Indian Software Services and ITES-BPO Sector



Source: NASSCOM

As a large developing nation, India has many shortcomings including high rates of poverty, corruption, and illiteracy; a substandard infrastructure; excess government regulation; and various other problems typical of a poor nation. These obstacles are offset by a number of strengths especially for software and services production. It has a long history of producing capable mathematicians. It has a large population with adequate English language capability. There is a large cadre of Indian managerial and technical professionals working in North American and, to a lesser degree, in European high-technology occupations and organizations. For those who can afford it, India has a strong and highly competitive K-12 educational system emphasizing science and mathematics. Although India has a democratic socialist tradition with high levels of bureaucracy and over-regulation, it does have a market economy. These are all advantage that India has over China in establishing a software services industry.

History of IT in India

The roots of India's entry into the global IT industry can be traced to its initial highly protectionist regulatory environment (Heeks 1996). As in many other nations, India's national policymakers focused on manufacturing. Protected from the global market and with a domestic orientation, Indian hardware producers never became global competitors. Because US firms established facilities in East Asia and homegrown Japanese, Korean, and Taiwanese firms became subcontractors and later producers, the IT hardware industry became concentrated in East Asia. Eventually, Taiwan emerged as the center for PC assembly and India became largely irrelevant for electronics manufacturing (Dedrick and Kraemer 1998).

The Indian software industry was established to serve the local market. Prior to the decision in 1969 by IBM to unbundle its software from its hardware that spurred the growth of an independent software industry, the only private Indian software firm was Tata Consultancy Services (TCS) which had been established in 1968 to serve the in-house data-processing needs of the Tata Group. Using a Burroughs mainframe, TCS began offering electronic data processing services to outside clients and also became Burroughs' exclusive India sales agent in 1970. India's first exports occurred in 1974 when Burroughs, recognizing the competence and cost advantage of the TCS personnel, asked TCS to install its system software at the offices of its US customers (Ramadorai 2003 quoted in Dossani 2006). Aware of the profitability of providing such contracts, other domestic firms were formed to offer similar services. Sending these programmers overseas to work on the client's premises became a common phenomenon, and was pejoratively known as body-shopping.

Factors Contributing to Bangalore, India as a Principal Site of Offshoring

Bangalore is considered by most observers to be the hub of the Indian IT industry. In fact, the United Nations Human Development Report has ranked Bangalore as a global hub of technological innovation. The city of Bangalore is the largest employer of software professionals in India, employing about 160,000 people in the technology sector of which IT services accounts for 100,000 employees, with the remainder in business process outsourcing and call centers.

***The general context.* Bangalore has had a number of advantageous events, some historical and some recent, that have contributed to the rapid development of its IT industry. These include the IT boom of the 1990s and the subsequent world demand for IT products and services, the rapidly falling price of hardware, the technological progress that enabled ever larger volumes of data to be copied onto disks of the same physical size, the explosion of the Internet and the rapid reduction in costs of sending data, the liberalization of the Indian economy in the 1990s, and the Y2K problem which came at the right time and showed that Indian IT professionals could deliver.**

***High-tech center.* From 1945, when Nehru became the prime minister, Bangalore was considered to be the science city of India. The state of Karnataka, of which Bangalore is the capital, is home to a large number of engineering colleges that provide a steady supply of highly educated, skilled workers for the IT industry. Bangalore also is the home to a number of large public and private sector organizations that employ many specialized skilled personnel working in high technology occupations. Though these organizations, such as the Indian Space Research Organization (ISRO), the Hindustan Aeronauticals Limited (HAL), Bharat Electronics, and Indian Telecom industries (ITI), are located in Bangalore and were important for creating the technology-oriented environment, they have not provided large numbers of technical personnel to the IT industry (D'Costa and Sridharan 2003). Among Indians, Bangalore has a reputation as the technology capital, though other cities such as Pune and Hyderabad are intent upon challenging this perception.**

***Local government policy incentives.* Policy liberalization was the tool used by the Karnataka state government to create the environment that facilitated the growth of the software industry. In the early 1980s, state officials made their first move which was to establish a Software Export Processing Zone in Bangalore. Since then the state government has acted to promote the industry's growth in many ways such as providing preferential treatment on land allocation, provisioning electrical supply, and (until recently) providing a better infrastructure than most other Indian cities. These incentives reduced the costs of setting up and operating an IT company. (See Chapter 8 and later in this chapter for a discussion of the**

national policy environment.)

Telecommunications infrastructure. **Texas Instruments had set up an office in Bangalore in 1984 and petitioned the Indian Government for permission to lease a 64k line to be used for transferring data from India to the United States. The Indian Government, both at the national and state levels, was worried what would happen if they provided a 64k line to a foreign company, and it took three years for them to approve the petition. Connectivity was through a local telephone exchange in Bangalore that connected to the government-owned long distance monopoly, BSNL. Service quality remained an issue.**

By the early 1990s, both Western and Indian firms were demanding better connectivity. Understanding the difficulties that business experienced when interacting with the government bureaucracy, the government established the Software Technology Parks of India (STPI). This organization was given permission to provide last-mile connectivity, establish free trade zone status parks, and generally facilitate the export software business. Bangalore was the first STPI and has continued to be the most successful. STPI solved the connectivity problem in Bangalore by installing a satellite dish antenna on its property (more recently replaced by fiber optic cable). Despite the liberalization of telecommunications in the late 1990s which led to drastically improved telecommunications service and lower cost, there remains a role today for STPI Bangalore that now serves at least 1300 companies.

Bangalore's rise to prominence was due to a confluence of factors. It was endowed with an excellent climate, a large pool of universities and governmental research institutions, and a relatively robust physical infrastructure. In the 1980s, it attracted US high-technology firms, such as Texas Instruments and Hewlett Packard, to establish operations there by offering them international telecommunications bandwidth. When these operations were successful, they had a demonstration effect that attracted other multinationals. Significant political support at the state government level ensured that the growth of the IT industry was facilitated. These factors combined to make Bangalore the leading IT center in India.

The Indian scene changed in 1978 when IBM decided to withdraw from India, following the passage of a law imposing joint ownership on all foreign subsidiaries. With IBM's withdrawal, the government formed and operated its own software firm, CMC. Though CMC proved to be only moderately successful,[7] it was in software and IT services that India would become globally competitive. At the time, the Indian firms did little more than recruiting, while an overseas intermediary secured the contract and the overseas client decided on the work for the programmers who were sent to the client's site. The initial focus of this body shopping was on systems installation and maintenance. Later, the conversion of clients' existing applications software into (primarily) IBM-compatible versions began, but this still operated on the basis of sending Indian workers to the client's premises. By 1980, the Indian industry earned $4 million in export revenue, shared between 21 firms, of which TCS and a sister firm (Tata Infotech) accounted for 63 percent (Heeks 1996).

At the beginning of the 1980s, the Indian software industry was small, but it was earning much needed foreign exchange. To encourage the growth of the IT industry and recognizing India's economic difficulties and foreign exchange shortages, Prime Minister Rajiv Gandhi's

[7] TCS purchased CMC in 2001.

new government liberalized IT imports in 1984 through the New Computer Policy. Import duties on hardware were reduced from 135 to 60 percent and on software from 100 to 60 percent. The software business was recognized as an industry, making it eligible for loans from commercial banks. It was also delicensed, that is, permits were no longer needed to enter the business. Delicensing was very significant because government licenses were required in most of the Indian economy. Given that most sectors of the Indian economy were off limits to new entrants, entrepreneurial energies were drawn toward deregulated sectors. In addition to creating space for new Indian entrants, wholly-owned foreign firms producing software for export were once more allowed, though on a licensed basis.

Electronics export processing zones were expanded to include software. TCS located in the first of these that was opened in Mumbai in 1973. Rentals in the zones were set below market levels and procedures to establish a business were simplified; power and water were guaranteed. Most importantly, in 1985, all export revenue from these zones was exempted from income tax (an exemption that is scheduled to end in 2007). These favorable policies encouraged additional entrants.

These privileges, particularly the tax exemption, had a significant effect on the structure of the Indian industry by making the domestic market comparatively less attractive; the combination of a tax exemption and foreign currency earnings was irresistible. Thus the Indian software industry was built on satisfying foreign demand for software services, not products. India was on the verge of bankruptcy during the entire period, and the rapid growth of the software industry and the fact that it was generating much needed foreign reserves meant that the government developed a strong interest in encouraging its growth. An important initiative to encourage growth was the creation in 1990 of the Software Technology Parks of India system which was authorized to further simplify procedures and enable exporters to import equipment against their export dollars without licensing or customs tariffs.

These liberalizations were providentially timed because they coincided with an important technical change in the software world, namely, the replacement of mainframes by workstations that generally used the Unix operating system and C programming language and were commonly linked together in a local area network (Dossani 2006). The adoption of workstations as a work platform facilitated a gradual shift in the location of work from the customer's premises to remote production in India. Further, the adoption of these standards generated work for Indian firms in converting clients' installed applications into Unix-compatible programs. The growth of this activity contributed to an increase in the number of Indian firms from 35 to 700 by 1990 (Heeks 1996).

Even as the Unix-workstation standard became more prevalent, a number of multinationals, including Texas Instruments, Hewlett Packard, and Digital Equipment Corporation, opened wholly-owned subsidiaries in Bangalore to take advantage of low-cost, high-quality Indian programmers to do various kinds of software-related development work. As part of the recruitment package, the government agreed to supply them with then scarce satellite bandwidth. Not much later, a few global banks with long-established Indian operations, notably Citibank, also began producing custom software in India. By 1990, Indian custom software developers were responsible for over 80 percent of all software exports.

Despite obstacles, the Indian software industry grew and accumulated a number of competencies. In 1991, the Indian government launched another wave of deregulation. There were 700 firms, including several multinationals, operating in India at the time. Most of these firms were small by international standards. The two Tata companies, TCS and Tata Infotech, continued to dominate the industry capturing 48 percent of total revenue. Most firms usually had just one client and so were vulnerable to that client's fortunes and disposition. Two-thirds of the typical firm's exports were to a single US client (Heeks 1996).

By the 1990s, the Indian government had become cognizant of the growing significance of software exports and the need to encourage this one bright spot in a bleak industrial climate. It now accepted that the industry required input from abroad. After the earlier rollback of duties, by 1991 the duties on software had again risen to 110 percent. In 1993, they were reduced to 85 percent; in 1994, they were further reduced to 20 percent for applications software and 65 percent for systems software; and, in 1995, to 10 percent for all software (Heeks 1996). Hardware duties ranged from 40 to 55 percent in 1995, but by 2000 had been lowered to 15 percent for finished goods such as computers, and eliminated entirely for components.

The global software business was also changing as revenues in custom software overtook product software. The custom software business was driven by the increasing size of software programs that firms were using for their internal operations. Growing demand, coupled with a shortage of US programmers, provided opportunities for the Indian IT industry to offer its services. The Indian industry focused primarily on assisting in the writing of the enormous software programs that were used inside large firms to control their various business functions.

Indian sales efforts were handicapped by government regulations preventing them from investing foreign exchange abroad. In the early 1990s, legislation was passed that allowed firms to invest foreign exchange earned from exporting in order to establish offices overseas. Previously, the Indian firms had only learned about their client's needs from their programming staffs on contract overseas, supplemented by occasional senior staff visits to the United States (and occasionally to other high-wage countries) and client visits to India. Operating a foreign office strengthened relationships with existing clients and provided access to mid-sized firms. Some firms established dedicated centers at customers' sites (Dossani 2006). At that same time, the Indian government changed its regulations to allow multinational firms to establish wholly-owned subsidiaries.

The Indian industry continued to evolve and find new software work. One important opportunity was the Year 2000 (Y2K) problem that became a serious issue in 1998. In itself, Y2K business was not so attractive as it was mostly unsophisticated work done at the client's site, but the Y2K business was important in other ways. It introduced additional foreign companies to the abilities of Indian firms and programmers, thereby expanding the Indian firm's potential customer base and increasing awareness of India as a destination for software work. Y2K prompted many firms to replace their legacy systems with standardized software platforms such as Oracle and SAP. This meant that Indians could train on global standard platforms and receive globally recognized certifications, raising client confidence.

The Current Status of the Software Industry in India

The Indian software and software services industry has experienced remarkable growth over the last thirty years. The Indian software services industry is based on the use of global software platforms and thus must purchase software licenses from foreign vendors. There is little available data on Indian software imports, however. Heeks (1996) cites Dataquest reports that in 1994-95 these imports were in excess of $96 million, and they have almost certainly grown many times over as the Indian software industry came to operate on standard platforms provided by US-based multinationals such as Computer Associates, Microsoft, and Oracle. To provide some idea of the number of software-capable people there are in India, according to Oracle (2005), India is the home to more than 220,000 members of its 3-million-strong online developer community, Oracle Technology Network.

Though this study concentrates on software offshoring, today not only software but also a great range of services are being offshored to lower-wage-cost environments (Dossani and Kenney 2003). Major software firms such as IBM, Microsoft, Oracle, SAP, and Veritas have relocated work to India. Because of the way the data is reported, it is impossible to separate the software work from the back office operations. However, as Table 1 indicates, a number of these firms have large workforces in India. In the case of Oracle and Adobe, approximately 16 percent of their global employment is now in India, and the number continues to grow. Other major software firms, all of whose Indian facilities were established far later than Adobe and Oracle, are also growing rapidly.

One myth about offshore facilities for multinationals is that their employment is limited to relatively low-skilled programmers. In February 2005, Oracle was advertising for 199 positions in its two facilities in India. Approximately 30 percent of these positions were for workers with Masters or Ph.D. degrees. Microsoft, newer in India, had a relatively less highly skilled recruitment profile, but they, too, were recruiting highly credentialed workers (See Table 2). Hiring such qualified employees, these Indian firms are likely to be capable of innovation in the future.

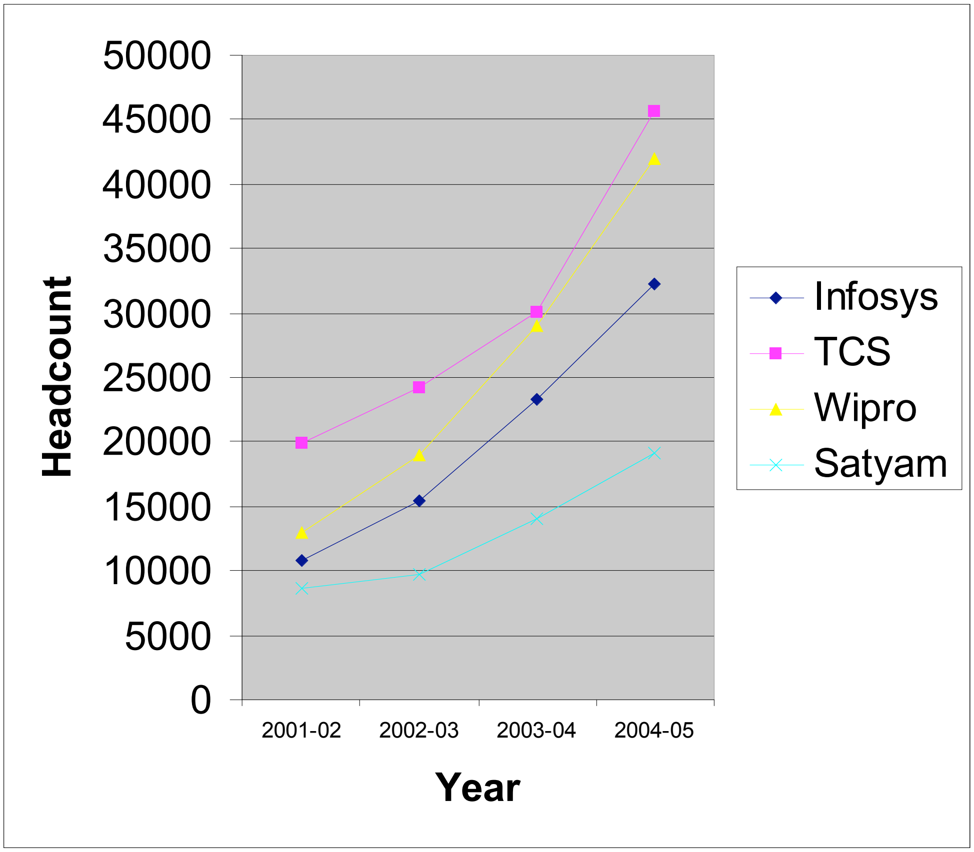
Table 3-2: Educational Requirement Posted for Job Openings for Microsoft in India and China by Highest Degree (Feb. 2005)

			MICROSOFT			
	None	**Technical**	**Bachelors**	**Masters**	**PhD**	**Total**
Beijing	2	0	0	1	0	3
Bangalore	2	0	13	5	0	20
Hyderabad	17	3	57	14	3	94

Source: Martin Kenney's compilation from various corporate websites (2005)

Like the multinational software firms operating in India, the Indian-owned software services firms are growing rapidly. They offer their services on outsourced software projects. As Figure 3 indicates, the major firms are large. Headcount at TCS and at Wipro, another major Indian firm, have already crossed 40,000 and are continuing to grow at 20-25 percent per year (CAGR). The stock market believes in these companies and places much higher values on them than on comparable US firms (Hira and Hira 2005).

Figure 3-3: Total Headcount at Major Indian Software Firms by Year

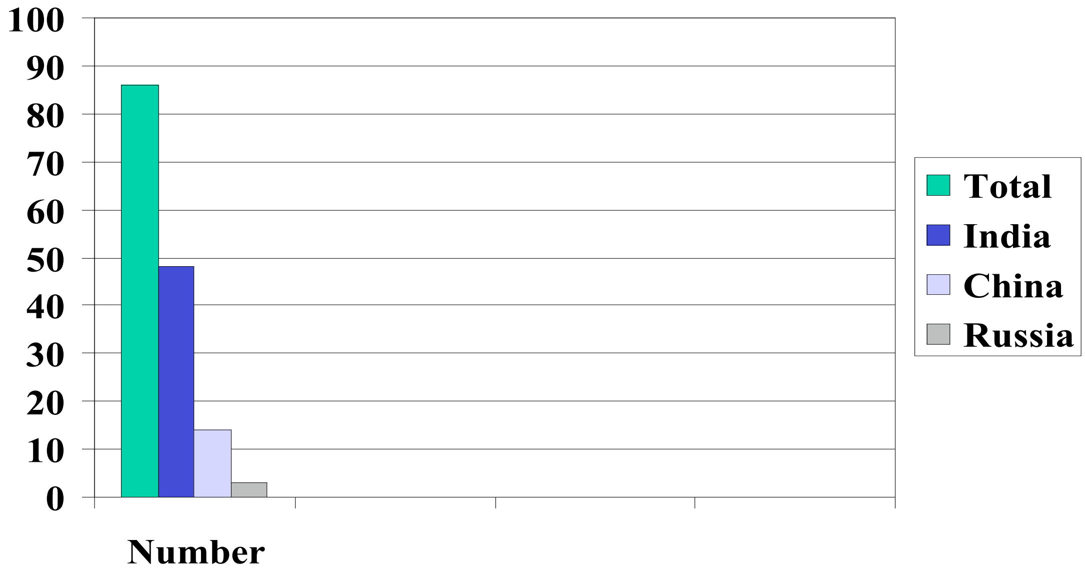


Source: Heng 2005:7, Compiled by Martin Kenney from corporate sources

The prices offered by Indian firms place enormous pressure on management in developed-nation firms to decrease costs so as to remain competitive. This resolves itself into a single issue, namely, getting costs per employee down. The way to do this is to move work to India or some other low-wage country. However, as Table 1 shows, many firms such as EDS, IBM, SAP, and Cap Gemini have relatively low percentages of their workforce located in India. From the of competitiveness perspective, this is no longer viable, and their Indian headcount is expected to increase significantly over the next few years.

There is significant evidence that a movement to higher value-added activities is occurring in both the Indian firms and the multinationals. In an Internet survey of the Top 86 U.S. software firms as identified by Software Magazine and conducted in December 2004, 48 firms had R&D facilities in India, while 14 had facilities in China, and only three were present in Russia (see Figure 4). There is also significant anecdotal evidence that US software startups are establishing facilities in India to save money and increase their headcount at low cost. (For further discussion, see Chapter 4.) This may have an indirect impact on the future growth of US software employment.

Figure 3-4: Number of R&D Operations in India, China, and Russia Operated by Top 86 U.S. Software Firms



Source: Internet searches by Martin Kenney

The Future of the Indian Industry

The Indian software industry is likely to grow in scale, scope, and value-added ability. There is little reason to believe that offshoring as a process will end in the foreseeable future, but it could slow down. The enormous investment by leading software multinationals will expand the number of Indian project managers with global-class managerial skills. This, plus the relocation of portions of startup firms to India, is likely to result in greater levels of entrepreneurship and enable firms to sell their skills on the global market at global prices. As a generalization, it is safe to say that this has not yet occurred, though I-flex, a former Citibank custom software firm recently purchased by Oracle, is now selling proprietary packages around the world (I-flex 2005). Other Indian independent firms may soon follow.

The offshoring of IT services and software for export will dominate the near future of the Indian software industry. There are several possible trajectories. Custom projects could become more complex and large, leading Indian software professionals to move from programming into systems integration, systems specification and design. The average size of projects Indian firms are undertaking has grown from 5 person-years in 1991 to 20 in 2003 (Krishnan 2003). As multinationals deepen their Indian operations, domain skills will develop in India so that managed services are likely to become more important. This will match global trends in the outsourcing of applications management and business processes.

Despite the fact that India's software production for the US market exceeds that of any other nation, it holds only a small share of the global market for all software value-added work. The only part of the software value chain in which India has made substantial inroads is in applications development where it has captured 16.4 percent of the world market. But applications development is only approximately 5 percent of the entire global software services market (see Table 3). This implies that there is much room for growth.

Table 3-3: India's Share in Various Sectors of the Software Services Industry (2003)

	Global software services spending ($ bn)	Indian software services export revenues ($ bn)	Indian service constituents by percentage (%)	Indian global market share of services (%)
Consulting	41.5	0.11	1.9	< 1
Applications Development	18.4	3.02	54.5	16.4
Managed services	124.9	1.94	35.0	1.6
System Integration: Hardware/Software Deployment and Support	91.7	0.37	6.7	< 1
System Integration: Applications, tools and O/S	62.4	0.10	1.8	< 1
IT education and training	18.5	0	0	0
Total	357.6	5.54	100	
Product software	200	1.66		<1

Source: Dossani from Nasscom 2004, p. 36 and 106. Indian figures are for 12 months ending March 2003. Indian figures do not include product development and design of $ 0.56 bn and embedded software of $1.1 bn.

The Indian software and software services industries are booming. In 2004-2005, the entire software and services industry grew at 18.5 percent and reached an all-time high of $16.8 billion of which $4.8 billion was in the domestic market. The export earnings increased at an annual rate of 30.4 percent from $11.2 billion in 2003-04 to $12.0 billion in 2004-05 (Nasscom 2005). All projections for 2005-06 indicate that it will be yet another banner year.

A key issue for India is the future of applications development in the value chain. Applications development may become commoditized just as systems maintenance has, either due to automation or the development of products that are as good as custom applications. Applications development has been losing global market share to consulting and is slipping down the value chain. However, since information is a source of competitive advantage, it is unlikely that customized application work will disappear altogether. In order to grow, the Indian industry will have to shift to more complex activities by securing larger projects, undertaking engineering services, integrating and managing services, or bidding on projects that include transforming a client's entire work process.

Increasing the value-added and IP components of Indian software services is difficult. For example, Cognizant CEO Narayanan argued that India did not yet have the capability to develop intellectual property, pointing out that R&D's contribution to overall growth is minuscule, and multinationals generally use their Indian R&D operations to upgrade existing products, not develop new ones (Economist 2004). Sarnoff India head, Satyam Cherukuri, argues that India has two of the three requirements for innovation, technical skills and access to capital, but lacks an "indigenous business model" (Economist 2004; D'Costa 2003).

Despite the assertion of many, it is plausible to argue that there is a significant entrepreneurial movement emerging in India. It could be said that there have been two clear waves of entrepreneurship already. The first was the establishment of firms such as Infosys, HCL, and Hexaware who created body-shopping businesses that evolved into the offshore programming model. Though entrepreneurial in genesis, they were pure labor-cost arbitrageurs. More recently, that situation may be changing.

The second wave of entrepreneurs consists of a few startups that are producing their own IP and marketing it globally. One of the most successful is I-Flex which was established by Indian executives who spun out of Citicorp's Indian software subsidiary. I-Flex developed a banking software package that is now being used by more than 50 medium-sized banks around the world. Today, there are only a few other examples, but given that an increasing number of Indian managers and researchers are acquiring experience in the Indian R&D laboratories operated by US firms, there is the potential for more of these startups.

Software offshoring to India is likely to grow not only through the continued growth of indigenous Indian firms, but also because foreign software firms feel compelled to increase their employment in India in product development and particularly in software services. Including not only software and software services but also other services, Accenture hired 1,600 employees in May 2005 in India and has announced that it will be hiring 50,000 more workers in India, China, and the Philippines in the next three years. IBM, which had 6,070 employees in India in 2002, saw the number rise to 24,150 in 2004. The company has a target of raising this number to 38,196 in 2005, an addition of 14,000 employees in just one year. CapGemini India plans to grow to 10,000 employees by 2007. Large multinationals, such as IBM and CapGemini, are competing with Infosys, Wipro, and TCS for offshore supremacy. As Indian companies move to global markets in their quest to expand the offshore model, these large multinationals are moving to low-cost destinations, taking the big Indian firms head on. The Indian firms are likely to face tough competition in the near future.

The cost advantage in India may diminish as labor costs increase and the rupee appreciates against the US dollar. However, interviews conducted by Rafiq Dossani and Martin Kenney indicated that costs were generally increasing rapidly only for experienced managers (15 to 20 percent per annum), while wages for beginning college graduates were increasing more gradually (5 to 10 percent per annum) (Private communication, 2005). Today, the cost of an Indian college graduate is $6,000-7,000 per year, while a US graduate is in excess of $40,000 per year. In addition to wage costs increasing among the more experienced managers, there is a generalized phenomenon of high turnover due to a supply-constrained labor market. This turnover affects projects and may have a detrimental effect on capability development both at the individual and corporate level.

There is much discussion of the high quality of the Indian IT labor force, but this may be deceiving. NASSCOM indicates that only about 27 percent of the employees in the Indian IT industry have an undergraduate or graduate degree in computer sciences or electrical engineering. In spite of India having 247 universities and 11,549 colleges in 1997, only 7 percent of the student-age population attends a university (Nasscom 2005). India has 0.3 scientists and technicians per 1000 population, ranking 42 out of 62 countries as ranked by the World Bank in 1998, below China at 1.3 (ranked 25th) and Ireland at 2.0 (ranked 20th). This lack of highly educated workers may slow India's advance into higher value-added sectors of the software industry.

Despite much improvement in the value-added per employee, India continues to trail the United States in this regard. In India, revenue per employee in software services has risen from $16,000 in 1990 to $33,000 in 2003. However, this is far behind the US average of $142,000. This differential suggests that US workers are still more productive than those in India, probably because a significant portion of the US revenue is in software products where revenue per employee is much higher than in software services.

Improvement of the value-added per employee will require a continued upgrading of the Indian workforce. The leading Indian software firms are investing in their workforces, but there is only so much training an individual firm can undertake particularly in the high turnover environment that characterizes the Indian labor market. Thus much of the responsibility falls on the central government which is the main financier of tertiary education. While India has greatly expanded the university system, problems with quality appear to have deterred enrollment.

The interaction between university and industry is minimal. There are few academic-industrial research partnerships as well as few consultancy assignments for faculty in industry. On campus, little independent research is undertaken. Until recently, faculty (even at the Indian Institutes of Technology (IITs)) have not been expected or funded to do research. Only in 2005 did the Indian government appropriate $250 million to establish a National Science Foundation. For example, at IIT Delhi, the value of sponsored research and consultancy assignments in 1998 was only $4.5 million (Parthasarathi and Joseph 2002). Faculty salaries are low, and NASSCOM concluded, "Over the years, there has been a general decline in the quality of faculty in Indian universities" (Nasscom 2002). The average number of citations over a five-year period for a faculty member at the Indian Institutes of Technology is less than three. This compares with 45 per faculty member at MIT and 52 per faculty member at Stanford University (Nasscom 2002). The country produces only 300 master's degree graduates and 25 Ph.D.s in computer sciences each year, compared with US numbers of 10,000 and 800, respectively. (For more information on the Indian educational system, see Chapter 7.)

The Indian subsidiaries of multinationals are perhaps even more important than the independent Indian firms. The reason is that the multinationals are more willing to undertake high value-added activities such as software product development within their own captive firm in India than they are to send the work to an Indian independent firm. It is within these subsidiaries where the highest value-added activities, such as globally directed research and development, take place. For at least the medium term, India should be able to retain its position of primacy for software offshoring from the English-language world. In the longer term, unless India makes an even greater effort to upgrade its universities and the technical capabilities of their graduates, China may become an important alternative destination.

3.5 China

China is one of the fastest growing economies in the world and is now the seventh largest economy in the world in terms of gross domestic product and the second largest economy in the world when the GDP is corrected by purchasing power parity. During the last two decades, it has become a manufacturing powerhouse. In 2004, the United States had a $162 billion trade deficit with China, the largest trade deficit with any single nation in US history.[8]

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[8] These statistics can be found at

China manufactures a broad range of goods, including IT products such as personal computers, routers, monitors, cell phones, and handheld devices. The manufacturing of IT products in China is growing more rapidly than China's overall industry. From 1990 to 1999, the Chinese IT industry grew at a rate of 32 percent per annum (Dong 2004). From 2002 to 2003, sales increased at approximately 34 percent to reach $235 billion, and China became the third largest IT equipment producer in the world (STAT-USA 2004). IT exports continue to grow rapidly. For example, in the first seven months of 2003, China exported $80.6 billion, representing approximately 50 percent of its total production (China Venture Capital Research Institute 2004). The strength of the Chinese IT hardware industry is shown by the purchase in 2005 of IBM's PC division by Lenovo. There is ample reason to believe that China may soon become the largest IT product exporter in the world.

China and IT Software and Services

Much less is known about the Chinese software industry than is known about the Indian software industry. The Chinese IT and software and service industries (ITSS) do not appear to be having an important impact on the global economy, though as we shall discuss later in the section on Japan, there are Chinese ITSS exports, and they are expanding rapidly but from a far smaller base than in the case of India. According to the Chinese Software Industry Association, there are 300,000 workers employed in over 6,000 firms, of which approximately 160,000 are software professionals, approximately 25 per firm (Tschang and Xue 2005, 133). According to the Ministry of Commerce, the revenues of the Chinese ITSS industry increased from $7.17 billion in 2000 to $19.35 billion in 2003. During the same period, software exports increased from $250 million to $2 billion in 2003 (China Software Industry Association 2005). A recent report (Krishnadas 2005), notes that China's IT services revenues are rising but are barely half of India's $12.7 billion. Growth is driven by internal demand, and exports make up only 10 percent of total annual software service revenues. The Chinese Software Industry Association indicates that 60 percent of Chinese software exports in 2003 went to Japan and another 21 percent went to Southeast Asia to nations using Chinese characters (Liu 2004).

Despite the impressive growth, the Chinese software export industry faces many obstacles. It is extremely fragmented, and few firms are capable of undertaking large projects (Krishnadas 2005). As of 2003, only six Chinese firms had received certification through the Carnegie Mellon Software Engineering Institute's Capability Maturity Model Integration, and most of these had not achieved CMMI Maturity Level 3 (China Venture Capital Research Institute 2004). In contrast, all top 30 Indian software outsourcing firms had already received CMMI Maturity Level 5 (Krishnadas 2005).

Given China's role as a manufacturing center for the global economy, many manufactured products it exports contain embedded software. Programmers preparing embedded software often need to work closely with designers and manufacturers, and there is some evidence that a portion of this work may be relocated to China (Linden and Brown 2005).[9] At the moment, there are no estimates of the size of this market, but it could be significant.

The Chinese firms providing IT services to Western nations vary by size, but most are relatively small. There are Chinese firms offering offshore software services for the US market. At this point, the Indian firms dwarf them but, over the longer term, Chinese firms

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http://en.wikipedia.org/wiki/List_of_countries_by_GDP_%28nominal%29;
http://en.wikipedia.org/wiki/List_of_countries_by_GDP_(PPP);
http://www.economywatch.com/world_economy/china/;
http://www.census.gov/foreign-trade/statistics/highlights/top/top0412.html#total.

[9] India also is developing a strong embedded software design capability, both at the multinational and Indian firms.

may provide competition to India in providing service to US businesses. A number of the large Indian software offshoring firms have established subsidiaries in China for the purpose of capturing business in China and servicing the Asia-Pacific market. Meanwhile, the Chinese networking equipment firm, Huawei, employs nearly 800 engineers in India and has announced plans to increase the number of engineers to 2,000 by 2006 (Press Trust of India 2005). Although the outsourcing relationship between China and India remains tiny, given the growth both nations are experiencing, it is possible that they could eventually become significant.

In contrast to India where exporting is the goal of both the India independents and the multinationals, much of the IT and software services growth in China is in the domestic market. Multinationals have developed large operations bent on localizing their products and software for the Chinese market. China is the largest developing country market in the world, and, for certain products, it is rapidly becoming one of the overall largest markets in the world. Many foreign goods must be localized to meet the special requirements of the Chinese market. For this reason, China is becoming an increasingly important location for R&D facilities in a wide variety of industries, including software and electronics (Zedtwitz 2004). In an effort to tap the Chinese market and utilize Chinese production prowess, a number of US software firms as well as US, European, and particularly Taiwanese electronics firms have established R&D facilities in China. The Shanghai area is an important stronghold not only for computer machinery assembly, but also for semiconductor manufacturing and, on a slower track, semiconductor design (Reuters 2005). Most of these operations are geared to adapting products for the local market or doing production engineering; however, some are developing global product mandates or are doing research for the firm's global operations. One of the most celebrated of these is the Microsoft research laboratory in Beijing which as of November 2004 employed approximately 170 scientists and planned to add 80 more (Heim 2003). According to Huang (2004), "more than 70 technologies developed [there] are already used in Microsoft products, including software for Windows operating systems and graphics packages for X-box video games. More of the lab's latest software is slated for the next version of Windows due out in 2006." Global software leaders such as SAP, Oracle, and Adobe are also establishing or expanding their Chinese operations.

Given the general economic growth in China, the Chinese market for software is expanding rapidly. Today, US packaged software firms are having some difficulty in the Chinese market due to uncompensated software copying. Though China has joined the World Trade Organization, it seems likely that these difficulties will continue. One possible answer to the uncompensated copying is the current Chinese effort to move to open source software (Marson 2005). Were this to come to fruition, it would dramatically decrease the problem of uncompensated copying, but it would also have a significant impact on the future prospects for growth of the US packaged software industry.

Conclusion on China

Given the past growth record, the apparent opportunities, and the importance given to the software industry by the Chinese government, the Chinese software industry is likely to continue growing more rapidly than the rest of the Chinese economy, and probably faster than the software industry in the rest of the world. In the short term, the Chinese software and software services exports are focused on Japan (see Section 3.6). In the long-term, China could possibly emerge as a competitor to India in the general software export market. More easily predicted is that China will become an enormous market. Given the relative paucity of data, it is difficult to predict when China will become one of the largest software markets in the world, but given the number of Internet and cell phone users, the rapid roll out of broadband networks, and the gadget orientation of Chinese consumers, it might happen quickly. However, it seems unlikely that Chinese firms will be able to compete with the major Indian IT and software services firms in the near-term.

3.6 Japan

The Japanese software and software services industry had sales of about $140 billion in 2004 and is the second largest single-country market in the world, accounting for 10.8 percent of the world's IT industry. Further, IT and software services is the fastest growing industry in Japan. In 2003, there were 5,482 information service companies employing 567,060 workers in Japan. Of these, technical positions included 240,096 system engineers, 114,479 programmers, and 7,398 researchers. The number of software engineers in all industries is about 800,000. Thus, more than 40 percent of software engineers are working in the information/service industry (JISA 2004a).

As Table 4 indicates, Japanese software imports were $2.9 billion in 2003.[10] The type of software imported is specific to the nation from which it was imported. The United States is the largest source of software imports, and it overwhelmingly provides system and applications software. In contrast, the imports to Japan from China and India are mainly custom software. Japan imported $102 million worth of custom software from China and $38 million from India. Japan also received $262 million in software services from China and another $63 million from India (Umezawa 2005a).

Table 3-4: Japanese Software Imports in 2003 (US$ millions)

	Basic Applications	Applications	Custom	PC Games	IT Outsourcing	Total
U.S.A.	686	1,874	47	6	49	2,606
China	1	1	102	0	262	104
Ireland	0	45	0	0	0	45
India	2	0	38	0	63	40
Australia	0	0	26	0	26	26
Others	6	27	43	0	91	76
Total	695	1,947		6		2,901

The Japanese software industry differs significantly from that of the United States. Outside of a few fields such as game software, Japanese software firms develop custom software for the Japanese market. Few Japanese companies produce packaged software products. For those firms that do prepare packages, their market is almost exclusively domestic, and the entire industry, not counting game software, exports only $93 million.[11]

[10] The true value of the imports is much larger because all major foreign software package firms have subsidiaries in Japan. For example, Microsoft's Asia-Pacific earnings in 2003 were $3.437 billion (Microsoft 2004), and Japan is as large as the other markets combined so Microsoft alone probably earned more than $1.5 billion in Japan.
[11] For further information on Japan and offshoring, see Umezawa (2002; 2005a; 2005b).

There is no authoritative data on offshore software development for the Japanese market. The most reliable data comes from surveys conducted by the Japan Information Service Association (JISA). According to Tsukazaki (2002), 19,000 foreign engineers were working in Japan in 2001, and, during that year, 3,943 foreigners acquired the status of engineer. Of these, 61.8 percent were estimated to be software engineers. In the JISA sample, Chinese professionals were by far the largest group represented, followed by Koreans, and a relatively small number of Indians.

The typical pattern in the past has been for Japanese firms to import Chinese or Indian software engineers to work on projects in Japan. This has changed because the cost of dispatching Chinese software engineers to Japan has increased to the point where it is no longer attractive (Umezawa 2002). The more typical pattern in 2005 is that a Japanese customer identifies a need for custom software and engages a Japanese software firm. The Japanese software firm then contracts with a Japanese subsidiary of a Chinese firm to have the work done either by Chinese programmers in Japan or, increasingly, by programmers located in China.

Another mode of offshoring has emerged in which Japanese firms invest in China to form a wholly-owned subsidiary or a joint venture with a Chinese firm. The most popular locations for Japanese firms to operate subsidiaries in China are Dalian and Beijing. The other mode of offshoring from Japan is for Western multinationals to move their programming and back office functions from Japan to a lower-cost environment in China. Dalian's software industry has grown (from a small base) at over 50 percent annually in sales volume and reached $544 million in revenues in 2003 (Xiong 2004).

Japanese firms, such as Fujitsu, NEC, Sharp, and Sanyo have subsidiaries to produce software in India. For example, through a publicly listed affiliate, Fujitsu (in 2005) employs more than 2,000 workers in its four facilities in Pune. It is difficult to establish whether these operations support the Japanese market or the English-language operations of Japanese firms. Despite great effort on the part of Indian vendors, with only a few exceptions, their sales in Japan have been small.

Impact on Japan of Offshoring

The impact on Japan of IT and software services offshoring is uncertain for two reasons. First, the software services offshoring phenomenon is recent so that patterns are not yet well established and data is scant. Second, Chinese vendors generally do not conduct business directly with their Japanese customers so the role of the Chinese company is somewhat obscured. There is typically an intermediary such as a Japanese software firm or a US or European-based multinational, that holds the contract with the Japanese client; the Chinese company is a subcontractor. The Japanese software firms have typically retained the higher value-added activities in Japan.

Actual sales are relatively small. While sales of the Japanese information services industry are $141.7 billion, the share offshored is $480 million or only 0.3 percent of the total sales (Umezawa 2005a). This may underestimate the total amount of offshoring because many multinationals operating in Japan have begun servicing the Japanese market from China or India. For example, in 2004 the US consultant firm, BearingPoint, established a development facility in Dalian with 60 employees, and it planned to increase employment to 1,000 "as soon as possible" (Thibideau 2004). Although Dalian has just begun to grow as a software offshoring center, Western multinationals there already include IBM, General Electric, Accenture, Dell, and SAP. Among the Japanese firms in Dalian are Sony, Matsushita Telecom, Mitsubishi, Toshiba, Nokia, Omron, CSK, Alpine, Furuno Softech, FTS, and Sino-Japan Engineering (Xinhua News Agency 2003). Despite this rapid growth, these operations are still not significant enough to have much impact on the Japanese economy.

The movement of Japanese software production to China is likely to continue. However, there seems to be a division of labor emerging with Japan undertaking the higher-end software development, while the Chinese subsidiaries and subcontractors undertake the more mundane coding functions. This is borne out in the China Venture Capital Research Institute (2004) assessment of the situation, "the export to Japan was mostly done in the form of outsourcing, just like traditional manufacturing, what was subcontracted to our country was only the development of lower-layer modules."

Conclusion on Japan

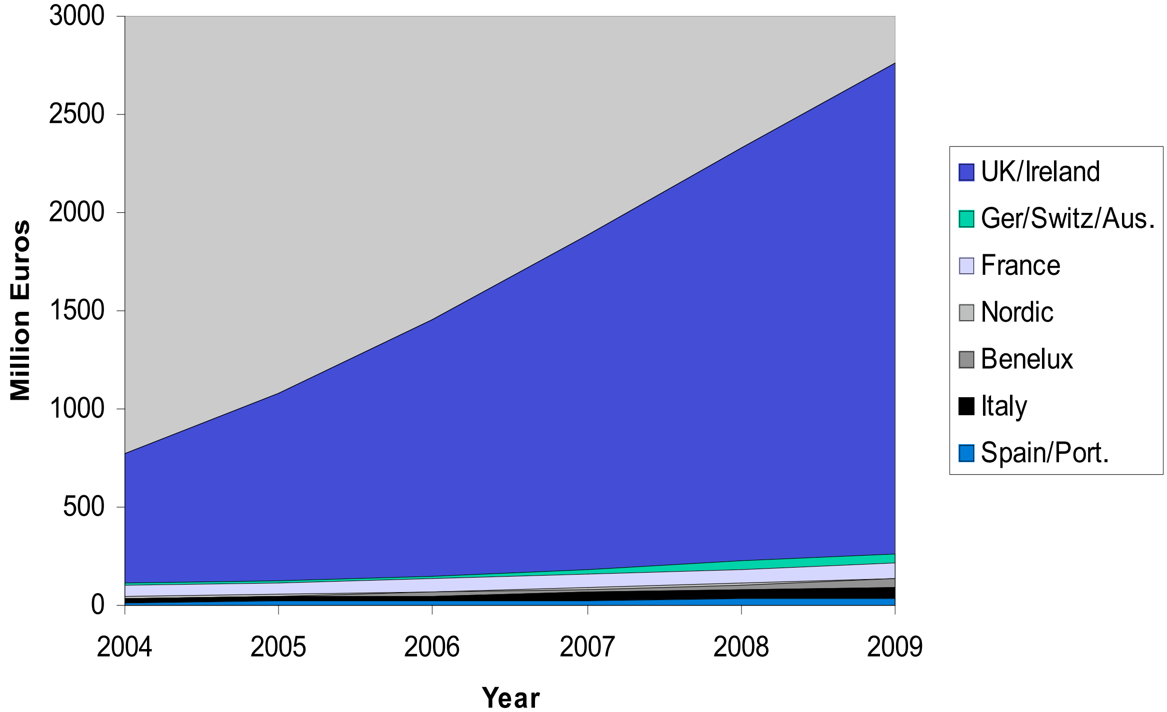
The amount of work offshored to China is likely to increase due to the increasing pressure to lower prices. Users are beginning to require that their Japanese vendors offer software development prices that assume offshore development in China. Given the strong linkages Japanese firms have with their customers, it is unlikely that Chinese firms will be able to establish direct relationships with Japanese customers. However, Japanese firms will be under pressure to reduce costs and thus will almost surely have to increase the scale of their Chinese operations or form alliances with Chinese firms. This suggests that Japan will not be immune to the pressure to offshore.

3.7 The European Union – Western and Eastern Europe

After the United States, the European Union as a whole is the second largest software market in the world. In 2004, Germany accounted for 8.1 percent (15.4 billion Euros), and the United Kingdom accounted for 7.1 percent (13.5 billion Euros) of the world software market (Heng 2005). This is much smaller than the US share of 44.5 percent (96.6 billion Euros). However, this statistic is somewhat misleading in that the Europe Union is not yet a single market but is rather a loose confederation of markets with different customs and languages. Europe has only one major software products firm (SAP). With the exception of SAP, US firms are dominant in Europe's packaged software market. Europe has no major software service firms. The European market for IT services is divided by national language differences. For example, Siemens Business Services is a leader in Germany, while Cap Gemini is a leader in France. The giant US software service providers, such as IBM, Hewlett Packard, and Accenture, play an important role in European markets where they usually face firms that are only significant in their home nation (see Table 3-1). The greatest European strengths are in software embedded in other products. Unfortunately, there are few statistics publicly available to gauge the size of the embedded software market.

The European Union has been slower to embrace offshoring than the United States. The United Kingdom was the first European country to do a sizable amount of offshoring, and it is responsible for almost two-thirds of the IT and service jobs offshored from the European Union (see Figure 3-5). Thirty percent of the jobs offshored come from Germany and Benelux, and there is a noticeable increase in interest in offshoring in the German-speaking nations recently. French, Italian, and Spanish firms have been more reluctant to send work offshore.

Figure 3-5: European Offshore Services Spending by Region



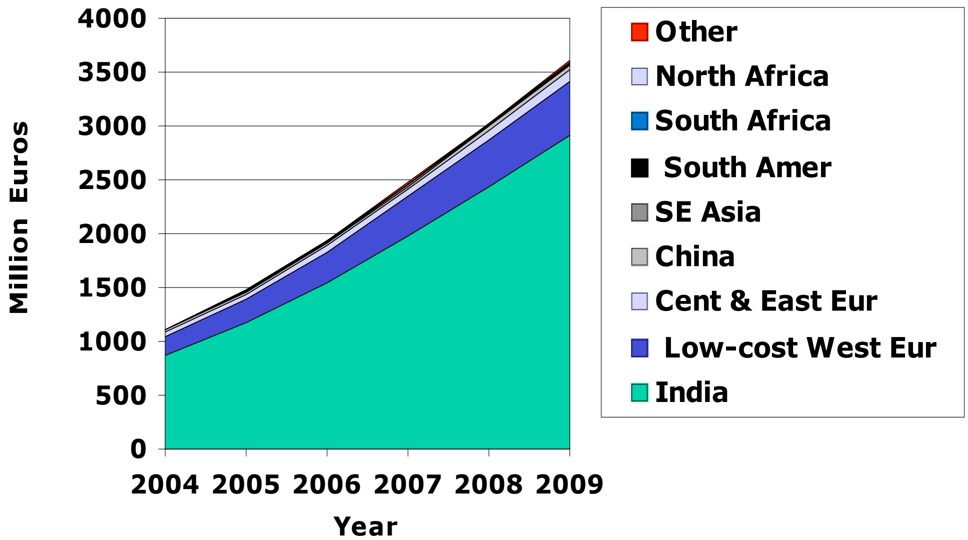
Source: Parker 2004

Cost pressures are driving Continental European software and software services firms to consider offshoring. According to a study by the consulting firm Roland Berger Strategy Consultants (2004) in which executives at 93 major European firms were interviewed, almost 40 percent of the firms have already relocated some services offshore, and 50 percent of all of the firms intended to offshore more activities. The firms already offshoring gave the strongest indication of willingness to offshore new functions in the future. There is anecdotal evidence that offshoring is increasing across Continental Europe. For example, in 2005, the Renault-Nissan alliance awarded IT services outsourcing contracts worth approximately $600 million to two US firms, Hewlett Packard and Computer Sciences Corporation, and the French firm Atos (Ovum 2005). With this outsourcing contract, much of the work will be transferred to lower-cost environments since all three of these firms have global operations.

Where the work is sent divides primarily along language lines. The United Kingdom sends most of its work to India, while the Western European nations speaking languages other than English are more likely to look to Eastern Europe. Due to the European Union's expansion into Eastern Europe, this is a natural near-shore location for the movement of services. A significant percentage of Eastern Europeans speak a Western European language such as German and, in the case of Estonia, Finnish. Hungary, Poland, and Romania are seen as prime sites for this nearshoring work.

Although many studies predict that Eastern Europe and Russia will receive much of the future offshoring work from Continental Europe, Figure 6 shows that, for Europe overall, the most attractive location by a considerable margin will continue to be India. India wins on price. For example, even though Romania is one of the lower-wage Eastern Europe destinations, it still has wages that are higher than those in India. India also wins on language and culture factors for the United Kingdom.

Figure 3-6: European Offshore Service Spending by Recipient Location



Source: Parker 2004

Germany provides an interesting case study. A sample of 93 major German industrial firms conducted by Horst Wildemann (2005) of the Technical University of Munich found that, of the firms that have offshored, 29 percent sent their work to Eastern Europe, while 46 percent went to India and China. R&D and administrative functions were areas that received considerable attention. This study also showed that the number of firms planning to offshore service functions is increasing and predicts that Germany could lose 152,000 jobs per year, for a total of 758,000 jobs potentially lost in the next five years. A recent study by A. T. Kearney (2004) predicts that by 2007 Germany will lose 130,000 jobs to offshoring. Although German labor unions have resisted offshoring, the state government of Bavaria is actively advising small and medium-sized enterprises on how to offshore their IT functions.

Cost reduction is the prime driver of this offshoring for German firms. According to the Roland Berger report (2004), the cost savings achieved through service offshoring were typically in the range of 20 percent to 40 percent with an average of almost 30 percent, which is similar to the results reported by Dossani and Kenney (2003) for US firms offshoring to India. The wage differential between Germany and Eastern Europe is significant. For example, in Germany, a systems engineer with a university degree and three years experience earns between 57,000 and 63,000 Euros per year, while a counterpart in Poland receives 15,000 to 18,000 Euros per year. Eastern Europe also has the advantage in that there are no time zone differences to complicate communication. Nevertheless, India and China are 50% less expensive than Eastern Europe which may be a determining factor is some offshoring destination decisions.

SAP and Globalization of the European Packaged Software Industry

SAP is the only major package software firm in Europe. Established by a group of former IBM Germany managers and headquartered in Walldorf, Germany, SAP had global sales of $9 billion in 2004. In keeping with its global reach, the company has internationalized its sales, support, and development operations, and staffing is growing in India in particular. The company employed approximately 32,000 people globally in 2004, including 13,500 workers in Germany, 5,000 in the United States, and 1,500 in India. SAP's operations in Bangalore are not only at the low end. For example, the Bangalore facility is developing software dealing with international taxation which will be sold globally. However, with the exception of SAP, it does not appear as though the European software industry will significantly increase its strength in packaged software and thus, in packaged software, it is unlikely that the employment offshored by the other software firms will be large.

Case Study: Siemens Business Services and Globalization of European Software Services

Siemens Business Services (SBS) is a Siemens subsidiary that does software and other outsourced production work on a global scale. It employs approximately 36,000 workers and has developed a strong business in helping companies to implement SAP software. Its 2004, revenues of 4.8 billion Euros came from Germany (48 percent), the rest of Europe (39 percent), the United States (8 percent), and the rest of the world (5 percent) (Siemens Business Services 2004). Like many other large service firms, SBS has been globalizing its service delivery operations and, in the process, downsizing its domestic workforce. Of the company's 36,100 global employees, only 15,100 are now located in Germany, and 4,000 are located in its rapidly growing Indian subsidiary.

SBS has developed a customer service strategy that uses a matrix of vertical industry knowledge and sets of general competencies. One aspect of the matrix is the industry expertise (vertical knowledge) concentrated in competency centers that are scattered across different nations. For example, the paper and pulp vertical center is located in Finland (Hallez 2004). The other part of the matrix involves general activities, which are located in offshore sites in Canada, Ireland, and Turkey to handle stabilized processes. India has two roles: it functions as a back office operation for finance and accounting, and it does general software programming and service and applications development for SAP programs. SBS uses Russia for very labor intensive and repetitive back office and software application development (Hallez 2004).

Conclusions on Europe

The European software industry and employment pattern is different from that of the United States with much software production done in-house and embedded in physical products. This does not prevent offshoring, and certainly many leading European industrial firms are establishing offshore facilities to produce embedded software. Much of this employment is subsumed under research and development and other activities such as application-specific integrated circuit design that are not directly relevant to this report.

Continental European firms continue to lag the Anglophone nations in sending software work across their borders. The Germanic and Nordic nations have only recently begun to build offshore software and software service delivery capabilities, but firms with global practices such as SAP, SBS, and others are moving rapidly to build their offshore capabilities in Eastern Europe, China, and India. The geography of European offshoring will be somewhat different from that of the United States in that Nordic and German firms will use Eastern Europe and Russia in addition to India. Those parts of Europe speaking a Romance language as the predominant language have been slower to begin offshoring. But now their major firms are sending work to Romania, Francophone Africa (particularly Morocco), and Latin America, in addition to India. There is no reason to believe that the pressures to offshore software-related work in these Romance-language countries will be substantially different from in the Anglophone nations. Given that US-based multinationals with strong global delivery capabilities, such as IBM, EDS, Hewlett Packard, and Accenture, are present and competitive in all European markets, there are cost and delivery pressures on companies throughout Europe to offshore, similar to the pressure on US firms. The only possible mediating factors that will make the European and US situations different are union and government opposition to offshoring in Europe. The most likely impact of this opposition is a delay in offshoring, not a change in the final outcome.

3.8 Russia

In Russia, the largest state formed out of the former USSR, software was traditionally a relatively neglected field outside the military. In the late 1980s, software comprised only 1.5 to 2 percent of the total outlays on computer systems, while the corresponding figure was 50 percent in the United States. At the time, there were reportedly few highly skilled professionals among the country's 500,000 programmers (Katkalo and Mowery 1996). In the 1990s, Russia began a transition to a market economy, and many skilled software engineers left the low-paid state enterprises, research institutions, and universities. They either emigrated or moved to multinationals or Russian startups. The greatest international product success of any of these companies was the computer game Tetris.

Large US and EU firms are active in Russia. Russia's advantage is that, as a legacy of the Soviet era, it has "more people working in R&D than any other country, and ranks third in the world for per capita number of scientists and engineers" (American Chamber of Commerce in Russia 2001). Russia's investments in education mean that it has a large stock of technically trained individuals. On the other hand, a recent Forrester report indicates "while [the number of programmers in Russia] has increased during the past two to three years, there is still less total development capacity than any of the large global system integrators can provide in the United States or Europe alone (Hoppermann and Parker 2004)". Even though Russia has trained technical personnel, the local software market is small and undeveloped compared to those in Western Europe and the United States. Russian firms have yet to play an important role in producing products or participating in global software services.

Offshore software development in Russia represents a small fraction of the worldwide offshoring headcount, although the number appears to be growing rapidly. Hawk and McHenry (2005) estimated that the Russian offshoring software industry generated revenues of between $200 and $450 million in 2003 and employed about 15,000 of the 70,000 programmers in Russia.[12] The stock of potential programmers, that is, those with some training in programming, may be as high as 200,000 and, in 2003 alone, there were approximately 68,000 new graduates in electrical or telecommunications engineering, computer science, mathematics, and physics (Hawk and McHenry 2005). Using the most liberal definition of programmers, that is, college graduates from all disciplines who might

[12] In 2001, the American Chamber of Commerce in Russia (ACCR 2001) estimated that there were 5,000 to 8,000 professional programmers in Russia doing $60 to $80 million per year.

be capable of programming, it has been estimated that Russia could have graduated as many as 225,000 in 2003 (Hawk and McHenry 2005).

Wages in Russia are low. In 2001, programmers with less than two years experience were paid between $300 and $500 per month, while more experienced programmers earned between $600 and $1,500 per month. Wage rates are increasing rapidly. Hawk and McHenry (2005, 12) cited a 2003 survey that found that wages for development staff ranged between $380 and $1,200 per month, with experienced managers receiving from $700 to $1,900. Wages in Moscow were higher than these scales.

Contrary to the report cited, concerning the small number of high-skill programmers in the Soviet era, Hawk and McHenry (2005) report that the skill levels of today's Russian programmers is quite high quality and they are considered to be good problem solvers. On the other hand, project management skills are viewed as not so strong. Russia also presents a difficult business environment. Experienced managers are in short supply, and few Russian firms have secured certification from standards-setting bodies. Hawk and McHenry (2005) state that only recently have Russian firms applied for certification, and only Luxoft had reached CMMI Level 5 (Luxoft 2005). This may change over time as Russian firms become more experienced and hire IT managers returning from abroad (American Chamber of Commerce in Russia 2003). In addition, programmers with adequate English-language capabilities are in short supply, bandwidth costs are higher than in most of the other contracting nations, and the general legal environment in Russia is also quite uncertain.

The Structure of the Russian Software Industry

The independent Russian software industry consists of small firms. As of March 2005, the largest firm, Luxoft, had over 1,000 employees (Luxoft 2005). There are a few other firms in the 500 to 1,000 employee range. Despite this size limitation, Russian firms have won business from important multinational customers, including Boeing, IBM, Dell, and Citibank (Luxoft 2005; Hawk and McHenry 2005). A number of multinational corporations, including Intel, Sun Microsystems, Motorola, Boeing, and Nortel, have opened R&D centers in Russia to take advantage of the skills of Russian scientists and engineers. Intel is one of the firms with the most ambitious plans for its Russian operations. In 2004, it purchased two Russian technology companies, Elbrus and UniPro, increasing its total employment in Russia from 900 to 1,550 engineers and staff (Intel 2005). Sun Microsystems employs over 300 Russian technologists in Moscow, St. Petersburg, and Novosibirsk (Nicholson 2004).

Conclusion on Russia

In terms of cost, quality, and volume, Russia is an attractive destination for offshored work. There are a considerable number of capable, low-cost personnel available in Russia; however, the stability of the business environment and the capabilities of management preclude the type of massive growth seen in India or even China. The independent Russian software firms are currently too small to tackle the largest and most sophisticated projects. Russia's strengths appear to be a number of technically sophisticated engineers capable of doing cutting-edge research. Predicting Russia's offshoring future is difficult because of uncertainty regarding the continuing development of the system of higher education and more general political and economic uncertainty.

3.9 Conclusions

Despite the changing geography of software and software services production, the most important global relationship in software continues to be US firms providing software and software services to the world. What is new is the perception by managers that capable technical talent is available in developing countries, particularly India. For managers under intense pressure to reduce costs, offshoring is now considered a normal response, and there is a growing infrastructure of lawyers, executive search organizations, and accountants in place to facilitateit.

This chapter has reviewed the countries exporting work (e.g., United States, Western Europe, and Japan) and their relationship with the countries that perform the work (e.g., India, China, Eastern Europe/Russia). A few conclusions can be drawn from this survey.

In the absence of major political or economic changes, the movement of software jobs from developed nations to lower-wage environments will continue, perhaps at an increasing pace, due to global markets, lower costs, and increased access to skilled labor.

Much of offshored IT work today is in lower skill areas, but this is changing. The change in the nature of the work will require changes in the skills of the offshoring managers as well as the employees who perform the offshored work. For the developed nations, it will be critical to find ways to utilize this new resource of lower-cost IT workers to develop high value products and services. This will require improvement in and the evolution of the educational systems in both the developed and developing nations.

India has become the primary recipient of software and software services offshoring, and this situation will continue for the foreseeable future. However, India is only the largest beneficiary of the globalization of IT work. Any developing nation with properly trained personnel, good telecommunications linkages, and the right cost structure can participate.

As a useful simplification, it can be said that India is the global center serving all geographies, but that there are also regional divisions of labor emerging with Eastern Europe and Russia tending to serve Western Europe, and China tending to serve the Asia Pacific area, particularly Japan.

An emerging form of offshoring is the formation by multinational companies of in-house laboratories located in lower-cost countries. This is one of the ways that the developing countries can participate in more advanced research and development since traditional offshoring does not lend itself as easily to advanced work.

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