A R T I C L E S

A Dynamic Perspective on Next-Generation Offshoring: The Global Sourcing of Science and Engineering Talent

by Stephan Manning, Silvia Massini, and Arie Y. Lewin

Executive Overview

The seemingly unlimited availability of science and engineering (S&E) talent in emerging economies and the increasing difficulties of finding such talent in advanced economies have given rise to a new trend: the global sourcing of S&E talent. This paper examines the antecedents and dynamics of this trend. In particular, it examines the coevolution of macroeconomic forces, domestic and offshore national policies, industry dynamics, and firm-level offshoring capabilities driving today's offshoring decisions. The analysis exploits findings from the Offshoring Research Network (ORN) project. By taking a dynamic and multilevel perspective on next-generation offshoring, this paper may inform both firm-level strategies and national policy-making.

The disintermediation of business processes, information technology applications, and administrative and back office functions through offshoring is rapidly becoming an accepted mainstream business practice (UNCTAD, 2005). Offshoring refers to the process of sourcing any business task, process, or function supporting domestic and global operations from abroad, in particular from lower cost emerging economies. In recent years, two important trends have emerged. For a growing number of companies, reducing labor costs is no longer the only strategic driver behind offshoring decisions. Accessing pools of highly skilled talent around the world (Bunyaratavej et al., 2007; Deloitte, 2004; Farrell et al., 2006; Lewin & Couto, 2007; Lewin & Peeters, 2006) has emerged as a new key strategic driver. Related to this, offshoring is no longer limited to standardized information technology (IT) or business processes, but increasingly involves product development functions, such as engineering, research and development (R&D), and product design (Engardio & Einhorn, 2005; Lieberman, 2004; Maskell et al., 2006; Patel & Vega, 1999; Subramaniam & Venkatraman, 2001). These two trends in particular may lead to what we call the global sourcing of S&E talent. In other words, while in the past most companies would build up and concentrate their product development functions at home,

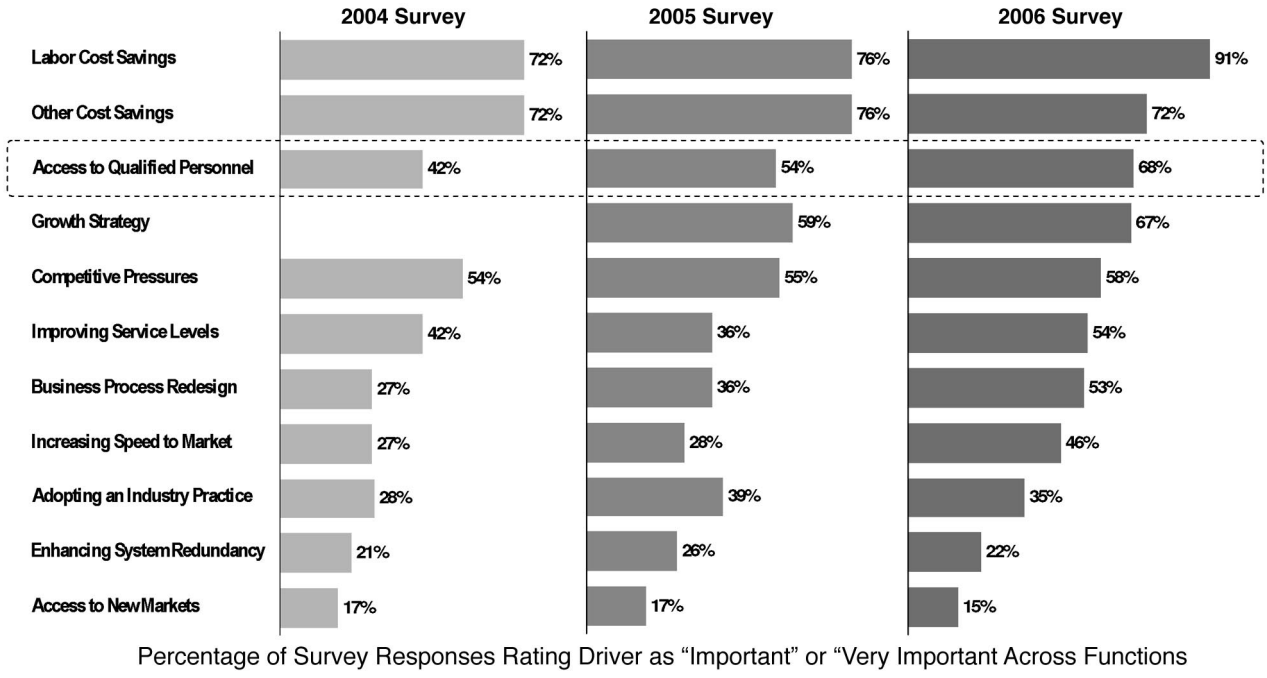
The authors wish to thank Associate Editor Timothy Devinney for his editorial guidance and four anonymous reviewers for their encouragement and insightful suggestions.

Stephan Manning *(sdm24@duke.edu) is Senior Research Associate at the Center for International Business Education and Research (CIBER) at the Fuqua School of Business, Duke University.*

Silvia Massini *(silvia.massini@mbs.ac.uk) is Senior Lecturer in Economics and Technology Management at Manchester Business School, University of Manchester.*

**** Arie Y. Lewin*** *(ayl3@duke.edu) is Professor of Strategy and International Business, Lead Principal Investigator of the Offshoring Research Network (ORN), and Director of the Center for International Business Education and Research (CIBER) at the Fuqua School of Business, Duke University.*

Figure 1
Changing Importance of "Access to Qualified Personnel" as a Strategic Driver of Offshoring Decisions



Source: Duke University/Archstone Consulting Offshoring Research Network 2004 and 2005 U.S. Surveys and Duke University/Booz Allen Hamilton Offshoring Research Network 2006 U.S. Survey.

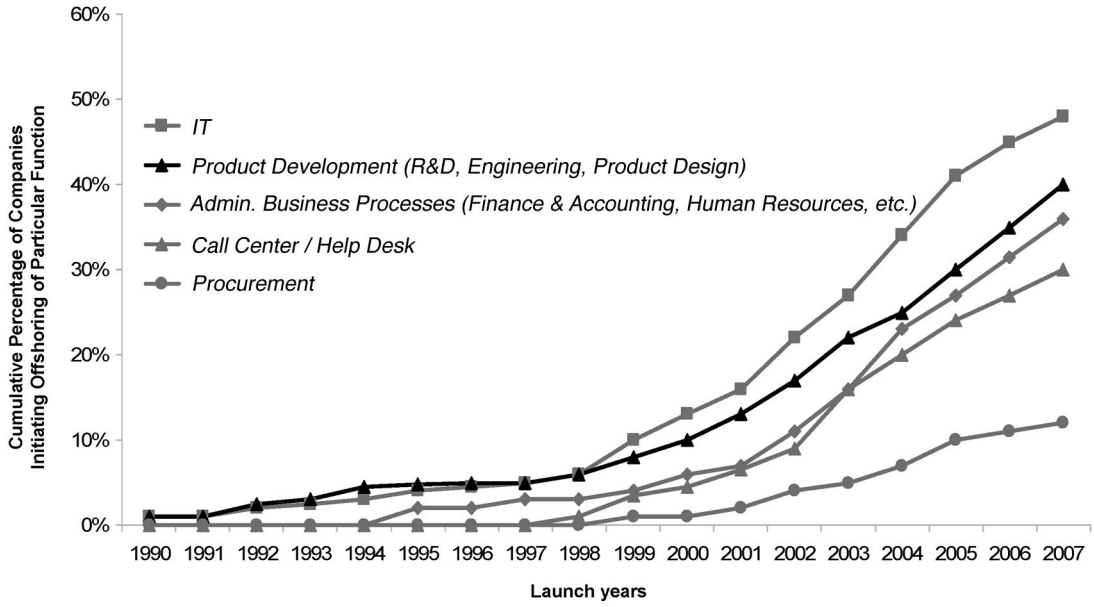
employing domestic science and engineering (S&E) talent, they have now begun to hire and use talent with S&E skills at globally dispersed locations.

This is a key finding of the annual Offshoring Research Network (ORN) survey, which was initiated in 2004 and which tracks offshoring activities of more than 1,600 large, mid-cap, and small U.S. and European companies at the level of discrete implementations (Lewin & Couto, 2007).[1] The survey tracks strategic drivers, risks, location selection factors, service delivery models, performance and job outcomes, and future plans. Survey results reveal that over the period 2004 to 2006 access to qualified personnel became the second most important offshoring driver after cost savings (see Figure 1), and that new product development—including product design, engineering services, and R&D—was the second most frequently offshored business function after IT (see Figure 2). Small companies in particular offshore product development functions: 38% of all offshore implementations by companies with fewer than 500 employees are related to product development functions, according to the 2006 ORN survey (see Figure 3; Lewin & Couto, 2007). Small companies see offshoring as an opportunity to increase speed to market for their new products or processes and to better access S&E talent. The increasing availability of external service providers offering new product development services and the opportunity for small companies to augment their limited in-house R&D capacity are further inducements.

While many articles, books, and reports have recently been published about offshoring, the complex dynamics of these trends is not well understood. This is because most studies have been rooted in certain research disciplines and focused on specific aspects or effects of offshoring on the firm, industry, or national economy level (see Table 1 for examples). For example, a number of papers—including a 2006 special issue of the *Academy of Management Perspectives*—have discussed the short-term impact of offshoring on do-

[1] The ORN survey was launched in 2004 and 2005 by the Duke Center of International Business Education and Research (CIBER) in partnership with Archstone Consulting LLC; in 2006 Booz Allen Hamilton became the lead corporate sponsor. The Conference Board has become the lead collaborator as of 2007.

Figure 2
Growth of Offshoring by Function

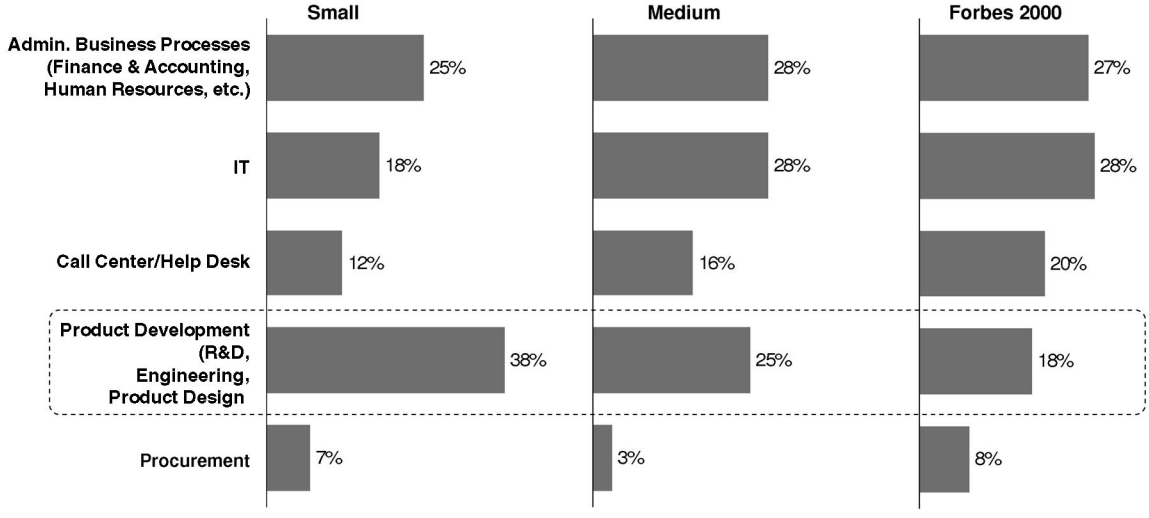


Source: Duke University/Archstone Consulting Offshoring Research Network 2004 and 2005 U.S. Surveys and Duke University/Booz Allen Hamilton Offshoring Research Network 2006 U.S. Survey.

mestic employment (Dossani & Kenney, 2006; Engardio et al., 2003; Farrell et al. 2004, 2006; Harrison & McMillan, 2006). Others have addressed technological antecedents of the relocation of particular functions such as IT (Henley, 2006), or research and development (Blinder, 2006; Ernst, 2002; Lieberman, 2004), or the rise of certain offshore destinations, in particular India (Dossani & Kenney, 2007; Reddy, 1997). Other papers have focused on the role of task features, outsourcing experience, and capabilities in making make-or-buy decisions (e.g., Gainey & Klaas, 2003; Holcomb & Hitt, 2007; Leiblein & Miller, 2003).

While these studies cover important aspects of offshoring, we propose that a more dynamic

Figure 3
Distribution of Functional Implementations by Company Size



Source: Duke University/Booz Allen Hamilton Offshoring Research Network 2006 U.S. Survey.

Table 1
Overview of Studies Related to Offshoring of Administrative and Technical Work

General Topic	References (Examples)	Outlet/Type	Focus of Studies (Methodology)
Global/General Level			
Economic drivers of offshoring	Antras & Helpman (2006), Blinder (2006), Markusen (2005)	Academic	Trends in international trade of services, comparative advantage of locations (economic modeling)
Technical drivers of offshoring (in particular IT)	Abramowsky & Griffith (2006), Blinder (2006), Ernst (2002), MacDuffie (2007)	Academic	Role of IT, modularization and standardization and digitalization of processes (conceptual)
Scale and scope of service offshoring	A. T. Kearney (2004), Bajpaj et al. (2004), Lewin & Couto (2007), UNCTAD (2005)	Consulting, practitioner-oriented	Offshoring trends, drivers, risks, location choices, savings, . . . (surveys; Foreign Direct Investment (FDI) statistics)
Global race for talent	Florida (2004, 2005), Frymire (2006), Hansen (2006), Lewin & Peeters (2006)	Books, popular press	Prediction of a global race for talent in a globalizing economy (references to recent surveys)
Impact of offshoring on global economy	Dicken (2003), Gereffi (2005), Levy (2005)	Academic	Changing interdependencies in global economy as a result of FDI activities (conceptual)
National Level: Economy, Policy, and Institutions			
Domestic vs. offshore talent pool (in particular, science and engineering)	Cervantes (2004), Dossani & Kenney (2006), Farrell et al. (2006), Freeman (2006), Kuptsch & Pang (2005), Lewin et al. (2008), Lowell & Salzman (2007), Martin (2005), Salzman (2007)	Books: business press and academic	Talent supply in the U.S., Europe, and emerging economies; role of education and migration policies and institutions (mostly based on annual statistics)
Domestic job impact of offshoring	Amiti & Wei (2004), Farrell (2004, 2005), Farrell et al. (2006), Harrison & McMillan (2006)	Academic	Prediction of job gains vs. losses as a result of offshoring; distinction between low-/high-skilled jobs (FDI, employment statistics)
Other impacts on domestic economy	Engardio et al. (2003), Garner (2006), Global Insight (2004), Lieberman (2004), Mankiw & Swagel (2006), Olsen (2006), van Ark et al. (2006)	Policy-oriented reports	Impact of service offshoring on prices, productivity, exports, wages (FDI, annual statistics)
Impact on developing economies	Patibandla & Petersen (2002), Reddy (1997)	Policy-oriented, academic	Role of investors in promoting economic development offshore (surveys, primary focus: India)
Role of innovation systems and clusters in emerging economies	Carlsson (2006), Ernst (2002), Intarakumnerd et al. (2006), Manning (2008), Zhou & Leydesdorff (2006)	Academic	Interdependence of innovation systems, clusters, and global economy (conceptual, partly based on surveys)
Business/Industry Level (Across Firms)			
Engineering/R&D	Helper & Khambete (2005), Kuemmerle (1999), Maskell et al. (2006), Patel & Vega (1999), Reddy (1997)	Academic	Drivers of offshoring R&D (conceptual, survey-based)
Financial services	Krishnaswamy & Pashley (2007)	Academic	Drivers and risks of offshoring financial services (survey-based)
Call centers	Beshouri et al. (2005), Ren & Zhoo (2007)	Consulting, academic	Performance, service quality of call center offshoring (survey-based)
Business processes	Kshetri (2007), Mehta et al. (2006)	Academic	Antecedents, constraints, and risks of Business Process Outsourcing (BPO) (empirical, conceptual)
IT services	Engardio (2003), Erber & Sayed-Ahmed (2005), Gu & Tse (2007), Henley (2006)	Business press, academic	Drivers of IT offshoring and outsourcing (survey-based, mostly focused on India)
Firm Level			
Offshoring decisions and strategies	Bunyaratavej et al. (2007), Lewin et al. (2008), Pyndt & Pedersen (2006)	Academic	Drivers of offshoring, choice of location, role of experience, demand for talent (survey-based and case-based)
Human Resource Management (HRM) strategies	Deloitte (2006), StepStone (2006)	Consulting, academic	Recruitment, retainment, and HR development strategies and challenges (conceptual)
Innovation/R&D capability	Dossani & Kenney (2007), Manning et al. (2007), Subramaniam & Venkatraman (2001)	Academic	Building offshore innovation capabilities, knowledge transfer (primarily case studies)
Outsourcing decisions and capabilities	Gainey & Klaas (2003), Holcomb & Hitt (2007), Leiblein (2003), Leiblein & Miller (2003)	Academic	Theory-based papers on strategic outsourcing decisions and capabilities, but often independent of decisions about location (conceptual and empirical)
Role of managers in offshore operations	Levina (2007), Manning et al. (2007)	Academic	Managers as boundary spanners and embedding agents (case studies)
Offshoring trajectories	Angeli & Grimaldi (2007), Dossani & Kenney (2007), Jensen & Pedersen (2007), Maskell et al. (2006)	Academic	Stages of service offshoring (e.g., from simple transaction-oriented to more complex activities) (mostly case studies)
Implications for organization theory	Doh (2005), Massini et al. (2008)	Academic	Implications of offshoring for organization theory (conceptual)
Collaborative strategies	Kedia & Lahiri (2007)	Academic	Choice of service delivery models for offshore operations (conceptual)

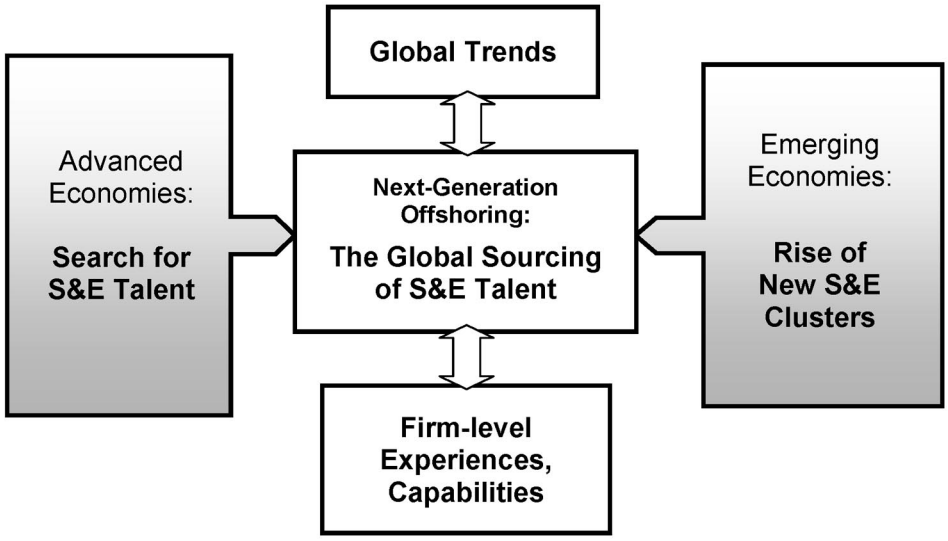
and comprehensive perspective on offshoring is needed to better understand more recent trends. More precisely, we consider key parallel and interrelated—or "coevolutionary" (Volberda & Lewin, 2003)—trends in advanced and emerging economies that have resulted in recent firm-level offshoring decisions. These trends include the increasing difficulty of finding S&E talent with advanced degrees (MSc or PhD or their equivalent) in the home country and the rise of new S&E clusters providing such talent in emerging economies. S&E clusters are new geographical concentrations of S&E talent pools and of external service providers that offer technical and other advanced services using S&E talent and at the same time compete for such talent. In addition, we consider firm-level offshoring experiences and organizational capabilities that have affected decisions to offshore product design, R&D, and engineering functions in recent years. The emergence and impact of these trends can best be understood by considering multiple levels simultaneously: macroeconomic, institutional/policy, industry, and firm. Taking both a multilevel and a coevolutionary perspective helps us better understand the connectedness rather than just the individual significance of each trend. As a result, we can develop a deeper and more nuanced understanding of offshoring and sketch out a more realistic picture of opportunities and constraints facing companies and policy-makers in advanced and emerging economies today. The concluding section of this paper addresses some of these practical implications.

The Dynamics of Next-Generation Offshoring

Offshoring of higher end business processes is a complex and dynamic phenomenon. In general, offshoring means that business functions supporting home-based and global operations are sourced from a location outside the home country. Often the terms *offshoring* and *outsourcing* are confused. *Offshoring* refers to the process of sourcing and coordinating tasks and business functions across national borders. *Outsourcing*, by contrast, denotes the delivery of products or services by an external provider—that is, one outside the boundaries of the firm. Offshoring may include both in-house (captive, or international, insourcing) and outsourced activities; outsourcing, in turn, may occur both domestically (onshore) and abroad (offshore). Further, offshoring concerns sourcing rather than sales activities, and it supports global or domestic rather than local operations. For example, setting up Human Resources (HR) departments in foreign subsidiaries in support of local operations (e.g., sales and distribution) is not what we mean by offshoring. Only if HR services (e.g., payroll services) are provided from offshore in support of global or home-based HR functions does the term *offshoring* apply.

In the longer term, as particular tasks are moved and specialized capabilities are established at multiple locations around the world, a corporate network of operations emerges, expands, and reconnects. Over time, the distinction between "home-based" and "foreign" operations can be expected to disappear, as centers of excellence and multiple regional service delivery bases are established (e.g., Holm & Pedersen, 2000). Along with this trend we expect that new product development functions will also be located at different places around the world and that S&E talent needed to perform these functions will be sourced globally. The internationalization of R&D is not a recent phenomenon (Cantwell, 1995; Granstrand et al., 1992; Kenney & Florida, 1994; Kuemmerle, 1999; Pearce, 1999). But with the exception of large multinational enterprises (MNEs) in small countries, which since World War II have historically expanded their R&D activities offshore (Cantwell, 1995), the home country remained the most important single location for R&D (Patel & Pavitt, 1991), and the organizational form was one of own and control. However, what distinguishes the new-generation offshoring is the relocation of high-end business processes and other administrative and technical services to low-cost developing countries and the variety of organizational and delivery forms. This globalization process is probably still in its early stages. The majority of high-end product development and engineering activities are still being carried out in the advanced Western economies (Disher & Lewin, 2007). However, as the global demand for S&E talent continues to grow, and as the domestic supply fails to keep pace with demand, new opportunities for locating offshore S&E opera-

Figure 4
The Dynamics of Next-Generation Offshoring*



*Modified from Lewin et al. (2008).

tions emerge. Thus, companies can be expected to increasingly source and use talent with S&E skills at globally dispersed locations. Ultimately this will fundamentally transform business practices. In the face of this rapidly emerging trend, a better understanding of the dynamics leading to next-generation offshoring activities is crucial.

Figure 4 introduces key factors and trends driving next-generation offshoring. They are primarily based on empirical findings of the ORN project as well as on other recent offshoring studies. These trends need to be seen as coevolutionary rather than in isolation. This is because only their parallel and partly interrelated development has led to the recent offshoring dynamic, which in turn can be expected to coevolve with the further development of these trends. To begin with, a number of global trends can be named that arguably have facilitated and are being reinforced by recent offshoring decisions (top box of the figure). Advances in, and the availability of, information and communication technologies (ICT) are often mentioned as a key factor (e.g., Blinder, 2006); we elaborate on this in more detail later. Other factors include increasing global competition and cost pressures across most industries and the standardization, modularization, and commoditization of advanced business operations and services that increasingly are simplifying the hand-off of tasks and global division of labor (e.g., Blinder, 2006; Helper & Khambete, 2005). At the same time, companies have developed organizational capabilities that enable and are, in turn, further applied in more complex sourcing decisions (bottom box of the figure). In particular, as companies become experienced in dealing with major offshoring challenges, such as wage inflation and employee turnover, they become more adept and confident in sourcing S&E talent abroad and in engaging in higher end offshoring activities. These capabilities are explored in greater detail in a later section of the paper.

In addition to these global trends and firm-level capabilities, two major factors have contributed to the recent trend toward sourcing S&E talent globally (see Figure 4): on the one hand, the increasing search for S&E talent by companies based in advanced economies (left box of the figure), and on the other hand, the rise of new geographic S&E clusters that provide talent with S&E skills in emerging economies (right box of the figure). How these trends have coevolved in recent years will be discussed in detail next.

The Search for Science and Engineering Talent

It was not that long ago that offshoring was solely associated with cost savings and labor arbitrage. More recent studies have suggested, however, that access to highly skilled talent is becoming a major offshoring driver (A. T. Kearney, 2006;

Deloitte, 2004), while labor costs continue to be an important factor. Some scholars and articles in the business press have even suggested that a "global race for talent" has begun and that recent offshoring trends reflect this phenomenon (Florida, 2005; Frymire, 2006; Lewin & Peeters, 2006). Findings from the 2006 ORN survey confirm that companies increasingly go where the talent is. Talent is broadly defined here as personnel with appropriate skills and qualifications. S&E talent refers to talent with S&E skills and qualifications, and includes in particular (mostly young) engineers, mathematicians, physical scientists, and computer scientists with advanced university degrees. For approximately 70% of all offshoring projects, access to qualified personnel was cited as an important or very important driver. As Figure 1 shows, the importance of this driver has grown significantly from the first survey wave in 2004 to 2006. Access to talent is a key driver especially for companies in high-technology industries (Lewin et al., 2008) and for those offshoring product development functions. This finding is consistent with earlier studies identifying talent as a main reason for offshoring R&D (Florida, 1997; Patibandla & Petersen, 2002; Reddy, 1997). However, in recent years, the global search for talent has increased significantly, which is likely to have a major impact on firm-level strategies and national policies, including education, innovation, and immigration policies.

One major driver of the global race for talent is the increasing difficulties firms perceive (or experience) in finding needed S&E talent in the United States and Western Europe (e.g., EC, 2006; StepStone, 2006). Indeed, the number of U.S. and Western European nationals or permanent residents graduating with S&E master's and PhD degrees has been stagnating or even declining since the mid-1990s (Butz et al., 2003; Deloitte, 2004; Freeman, 2006; Lewin et al., 2008; NSF, 2006). Some argue that high school graduates have lost interest in entering S&E careers because the inadequate training in mathematics and science in high schools does not qualify them to enter S&E careers in the first place (e.g., Cervantes, 2003; see also a critical discussion in Lowell & Salzman, 2007). Others argue that the perceived difficulty in finding domestic S&E talent with master's and PhD degrees is a case of market failure in creating incentives to select these careers and enroll in the respective science and engineering programs and disciplines—a mismatch between "market needs" and compensation levels, career opportunities, and the investments required to actually pursue S&E careers (e.g., Butz et al., 2003; Freeman, 2006). A third argument put forward is that many S&E jobs are perceived to have become too routinized and less challenging and "sexy," compared to, for example, projects in the space program or early IT ventures (Lowell & Salzman, 2007). These factors may explain not only the limited interest in S&E graduate programs, but the fact that increasingly S&E graduates enter other fields (e.g., banking and consulting) to better meet their career aspirations (NSF, 2006).

While the interest in S&E careers among U.S. national (or permanent resident) students has declined, the number of foreign nationals, mainly from India and China, who have graduated and started academic and business careers in the U.S. has increased (Freeman, 2006; Martin, 2005). Arguably, this trend started when U.S. companies faced a cyclical talent shortage in the mid-1990s. Unlike in earlier periods, when companies would respond to such a shortage by launching retraining programs or by offering higher wages and career incentives, they now had additional options for staffing job vacancies expeditiously with foreign talent (e.g., through the H1B visa quota program and offshoring to low-cost countries). The H1B option, for example, allowed U.S. companies to exploit labor cost advantages involving H1B employees. One possible consequence of these practices appears to be that S&E careers are increasingly perceived by many domestic high school graduates as less attractive—despite *rising* demand—which further affects domestic supply (Lowell & Salzman, 2007). In the past few years, however, the number of foreign S&E talent entering the U.S. has declined, while the return rate ("reverse brain drain") to home countries has been increasing. This is, to a large extent, due to a cutback in the H1B visa quota in 2003 (Lewin et al., 2008), increasing opportunities and incentives

for studying and doing research in S&E fields outside the U.S., and the emergence of attractive work opportunities and living conditions in home countries (Chanda & Sreenivasan, 2005; Lieberthal & Lieberthal, 2003; Zweig, 2005).

These developments could be foreshadowing a major shift in the structure of the global pool of S&E talent. As noted earlier, U.S. and European S&E graduate numbers are stagnating or declining, yet the pool of S&E talent in emerging economies, such as India and China, is growing rapidly (Bunyaratavej et al., 2007; Freeman, 2006). The percentage of S&E talent sought in these economies compared to domestic markets may still seem rather small (Farrell et al., 2006), but the total demand for S&E talent worldwide is increasing. According to Disher and Lewin (2007), global expenditures on engineering activities across industries will increase by 30% from 2006 ($850 billion) to 2020 ($1.1 trillion), and all of this increased work is expected to be undertaken outside the Western economies. Parallel to this, the share of investments related to engineering activities in India and China is predicted to rise significantly. While national investments in domestic higher education and career opportunities in the U.S. and Europe could counteract some of these trends, the retiring baby-boom generation, little population growth, and an aging population might work against these conventional policy levers. As a consequence, the potential talent pool available in developed countries can be expected to shrink further (Deloitte, 2004).

In response to the shift in the global supply of talent, U.S. companies are building new S&E operations in offshore locations—despite accelerating wage inflation in those locations. Recent studies show that decisions to offshore higher skilled functions are mainly driven by availability of qualified personnel, in spite of diminishing cost advantages (Bunyaratavej et al., 2007), in particular at hot-spot locations. However, as companies become able to standardize and modularize new product development and innovation processes, they also make more use of lower skilled talent—both offshore and onshore. Another strategic response, according to the StepStone (2006) study, is to increase investment in the internal development and retraining of the S&E workforce (e.g., to make better use of experienced staff). However, many companies may lack the incentives to provide longer term S&E careers and the capacity to retrain their S&E workforce. In this context, the growing numbers of self-employed "nerd techies" and the emergence of temporary staffing agencies specializing in accessing and placing these independent contractors (e.g., engineers, software developers) on demand worldwide represent an important new dynamic (Barley & Kunda, 2004). This is already leading to a restructuring of industries and is affecting the trend toward offshoring human capital more generally. As offshoring in search of talent becomes a common business practice, companies will find it even harder to justify a domestically focused talent-seeking strategy. That is, mimetic and normative isomorphic pressures (DiMaggio & Powell, 1983) can be expected to reinforce the trend toward offshoring human capital, leading to the unanticipated consequence of negating domestic education and immigration policies (Kshetri, 2007).

The Rise of New Science and Engineering Clusters

In recent years the growth in the global S&E talent pool has been especially notable in India and China, which feature growing young populations, growing investments in improving higher education systems, and increasing domestic career opportunities (Freeman, 2006; Zweig, 2005). While the formal qualification of a large proportion of S&E graduates in India and China remains below European and U.S. standards, the availability in those economies of S&E talent with comparable qualifications is forecast to increase significantly in the coming years. This is because national policies have transformed local universities, modeling their programs after U.S. and European universities and technical institutes and responding to the global demand for specific programs and degrees. Furthermore, national tax incentives, growing personal networks and communities of home-based S&E graduates, and the related perception of attractive career prospects are working to "reverse" the brain drain, attracting

S&E talent back to their home countries (Chanda & Sreenivasan, 2005; Zweig, 2005). In addition, both India and China are ironically benefiting from U.S. immigration and visa policies, which were initially established to attract S&E talent from abroad and which still provide opportunities for foreign nationals to get master's and PhD degrees in the U.S. Because of increasing job opportunities in their home countries and because of recent U.S. visa restrictions (e.g. dramatic decrease in annual H1B visa quota), many foreign nationals now return home after completing their degrees in the U.S. to pursue careers in their home countries.

This trend has contributed to the emergence of new geographical S&E clusters in emerging economies in general and in India and China in particular. Clusters are often associated with geographic concentrations of companies, institutions, and communities related to particular industries (Porter, 2000). Typical examples are Silicon Valley and Boston's Route 128 for the software and ICT industry. These clusters are important hubs of innovation for both local and global companies (Enright, 2000; Ernst, 2002).

The basic idea underlying the concept of a cluster was first described by Alfred Marshall (1920), who identified three key elements of what he calls "industrial districts": clusters of subcontractors, readily available skilled talent, and a knowledge base shared by a local community of firms and people. In the offshoring space, a similar phenomenon can be observed: New geographical concentrations of highly skilled talent and specialized service providers using this talent have evolved in India, China, and other emerging countries, which in turn attract multinational corporations as well as local companies. Unlike industry clusters in Western economies, such as Silicon Valley for IT companies or southern Denmark for biotechnology companies, these new geographic clusters tend to develop around particular functions or upstream services rather than industries. In support of this observation, ORN survey findings indicate that the choice of offshore locations varies greatly by the function or process to be offshored (e.g., IT, software, or product development) and much less so by the industry of offshoring companies. Bangalore is best known for having evolved into a cluster providing IT and software skills that multinational companies across industries use to better perform their IT and software development functions (Athreye, 2005; Bresnahan et al., 2001). Other examples include Moscow and St. Petersburg, where highly trained scientists reside who are hired to assist companies—again across industries—with the development of new products and technologies. Another related feature of these new S&E knowledge clusters is their utilization by multinational corporations rather than by local companies. Over time, these clusters tend to increasingly interlink and coevolve with global operational configurations of multinational corporations (Enright, 2000; Ernst, 2002; Manning, 2008).

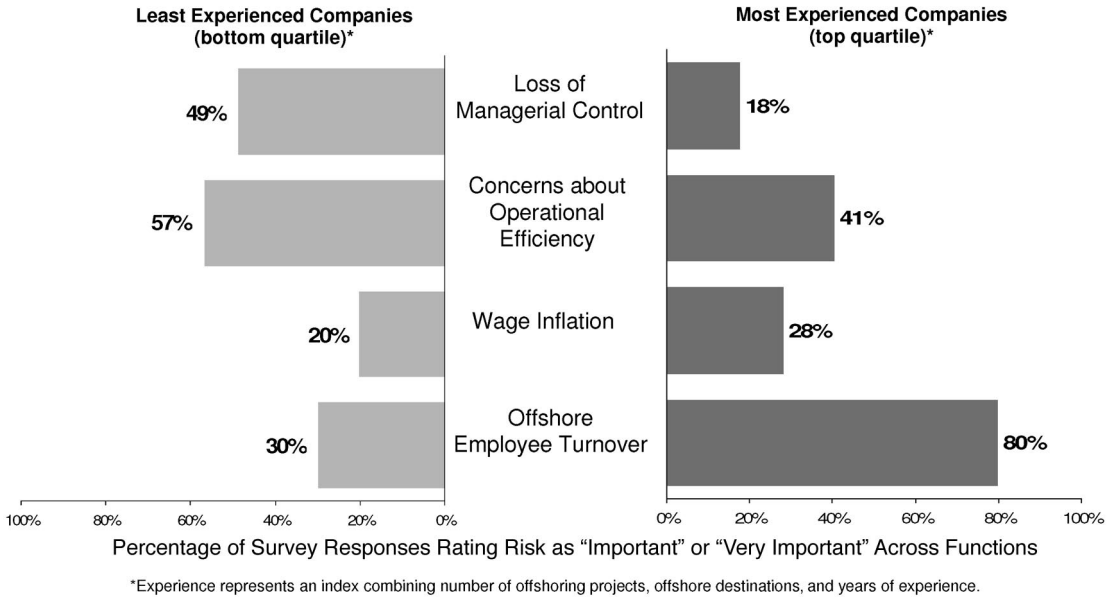
Comparing different countries in which those clusters have developed, India remains the most important one, in particular for ICT-related services and product development (e.g., Dossani & Kenney, 2007; Henley, 2006; Lieberman, 2004). Almost 50% of all IT and product development offshore projects by companies responding to the 2006 ORN survey were implemented at various locations in India. More than any other country, India provides a large pool of qualified software and S&E talent, at still relatively low labor costs compared to U.S. and European wage levels (A. T. Kearney, 2004; Garner, 2004). While wage inflation at hot-spot locations, such as Bangalore, is rather high, overall increases in labor productivity are offsetting this trend to a considerable extent. It is barely recognized in the literature that India's standing today is the result of national investments in education during the 1980s and the subsequent long-term development of S&E human capital. Strategic policy decisions by the government of India in the 1980s promoted the development of software industry clusters and attracted technology-oriented foreign investment (Dossani & Kenney, 2007; Patibandla & Petersen, 2002). A few companies, such as Texas Instruments, General Electric, Motorola, and Daimler, established technology centers and product development activities in India in the early 1980s and 1990s (Reddy, 1997). To some extent these investments were made to gain political favor (De-

lios & Henisz, 2003); however, over time, these companies have gained experience and developed capabilities that enabled them to expand India-based innovation activities and other operations. In parallel, Indian companies such as Wipro and Infosys have become experienced in providing IT and business process services to clients across industries (e.g., Athreye, 2005; Kedia & Lahiri, 2007), which has further attracted foreign investors. This factor, combined with the availability of flexible highly skilled S&E talent, has contributed to the perception of India as a preferred country for offshoring and outsourcing ICT and S&E-related operations.

India, however, seems to be gradually losing its attractiveness as the preferred offshore destination to other emerging economies (A. T. Kearney, 2004). China is often named as India's strongest competitor (e.g., Huang & Khanna, 2003). Both economies have in common a large population and potential pool of highly skilled talent, an improving education system, and a growing domestic consumer base. However, in terms of overall foreign direct investment, including manufacturing, China has always been ahead of India in the offshoring space (UNCTAD, 2005). This is primarily because the Chinese government enacted market reforms in 1978 to attract foreign direct investment, and a number of Western companies have established operations (mainly manufacturing and supply chains) in China (Lieberthal & Lieberthal, 2003). Not surprisingly, China is the most preferred offshore destination for procurement today (Lewin & Couto, 2007). Partly building on its advantage of having a large manufacturing base, China is also becoming an attractive location for product development activities (A. T. Kearney, 2004; Lewin & Couto, 2007). In particular, major metropolitan areas, such as Beijing, Shanghai, and Dalian, have developed into large S&E clusters attracting multinational corporations across industries. In support of this trend, China has vastly improved its telecommunication and transportation infrastructure and has further developed its education system and academic research potential (Buckley, 2004; Zhou & Leydesdorff, 2004). However, the low level of English language capabilities and institutional constraints, such as the weak intellectual property protection (which was introduced in 1980 but not reinforced at Western standards until China entered the WTO at the end of 2001), remain serious concerns among foreign investors (Huang & Khanna, 2003). Also, the China one-child policy is forecast to create a shortage in the supply of talent that is expected to accelerate wage inflation as China approaches 2020, when the age pyramid is expected to invert.

Moreover, local competition for talent in India and China, particularly in hot-spot cities such as Bangalore and Shanghai, is leading to wage inflation and rising employee turnover, which, according to the 2006 ORN survey, is driving more and more companies to seek alternative options. In particular small companies seem to choose among a greater range of potential locations (e.g., when it comes to offshoring product development functions). This is because a number of emerging economies, in particular in Asia, Latin America, and Eastern Europe, are catching up and are positioning themselves as second-tier offshore locations. More than India and China, these economies specialize in attracting particular business functions from companies based in specific regions of the world. For example, both large and small Western European companies (e.g., German companies) regard Eastern European countries, such as the Czech Republic or Hungary, as desirable nearshore locations for product development activities (A. T. Kearney, 2004; Lewin & Couto, 2007). These economies provide a qualified workforce, highly developed infrastructure, and greater cultural proximity (A. T. Kearney, 2004; Bajpaj et al., 2004; Marin, 2006). In particular, small companies offshore product development work to Russia and the Ukraine, where in recent years specialized small service providers have set up their operations. In contrast, the Philippines and Latin America mainly attract call centers and business processes from U.S. and Spanish companies respectively (A. T. Kearney, 2004; Lewin & Couto, 2007) that seek language-compatible, low-cost labor. In the medium term, other regions, not least in Africa (UNCTAD, 2005), are expected to emerge and attract companies interested in avoiding hot-spot locations and the problem of wage

Figure 5
Perception of Offshoring Challenges by Experienced Companies



Source: Duke University/Booz Allen Hamilton Offshoring Research Network 2006 U.S. Survey.

inflation (A. T. Kearney, 2004) and high labor turnover. The offshore space, therefore, needs to be seen as a dynamic competitive environment in which locations arise and evolve specialized clusters of talent with particular skills for certain business functions.

The Challenge of Sourcing Science and Engineering Talent Worldwide

With increasing opportunities to offshore and outsource innovation-centered activities and to recruit S&E talent globally come unexpected challenges. The 2006 ORN survey indicated that offshoring companies are increasingly concerned with service quality, loss of managerial control, and operational efficiency (Lewin & Couto, 2007). The more experienced companies, however, seem to have learned how to manage these challenges: They perceive them as less important offshoring risks, according to the ORN survey. At the same time, however, experienced companies are more concerned with wage inflation and offshore employee turnover as major managerial challenges (see Figure 5). These findings suggest that many companies discover these challenges *as* they engage in offshoring over time. Rarely are companies fully aware of these risks, nor do they have the organizational structures, processes, and capabilities in place to manage them from the start. However, this uncertainty does not seem to prevent many companies from going offshore or from expanding offshore operations (for a different view, see Farrell et al., 2006). Rather, a number of companies seem to develop organizational capabilities for sourcing and managing S&E talent globally "along the way"—by experimenting, by learning from experience, and by collaborating with strategic partners. This finding is consistent with empirical studies in the outsourcing field which suggest that prior experience with outsourcing helps firms make better outsourcing decisions (Gainey & Klaas, 2003; Leiblein & Miller, 2003). Over time, companies may reach a stage where offshoring more complex and demanding operations, including R&D, becomes feasible (Dossani & Kenney, 2007; Salzman, 2007).

Interestingly, the very organizational capabilities that successful offshoring companies are developing to make use of S&E talent globally have barely been examined or reported on so far. One notable—but somewhat misleading—exception is the use of advanced information and communication technologies. Many scholars have argued

that advances in ICT have enabled companies to globalize product development activities (Dossani & Kenney, 2007; Ernst, 2002). Some have even suggested that, with the use of ICT, all activities that require no face-to-face interaction, including engineering and product design, can in principle be offshored (Blinder, 2006). Several studies have illustrated, by the use of case examples, that the modularization and digitalization of product development processes is indeed a major facilitator in offshoring engineering work (Ernst, 2002; Helper & Khambete, 2005). Most of these studies, however, have two major shortcomings: First, they take a rather deterministic view on ICT advancement. They do not sufficiently recognize that advanced technologies need to be embedded in organizational cultures, structures, and practices to become and to be perceived as "useful resources" (DeSanctis & Poole, 1994; Dodgson et al., 2006; Orlikowski, 1992). Second, these studies focus solely on technical capabilities and contribute little to the understanding of how offshoring companies deal with some of the major challenges resulting (or emerging) from the relocation of higher-skilled functions, such as loss of managerial control and employee turnover.

In the section that follows we discuss some key organizational capabilities that have been largely neglected in the offshoring literature: recruiting, developing, and retaining talent; coordinating globally dispersed innovation activities; and collaborating with external partners. In line with the strategic management literature, these capabilities can be understood as "dynamic capabilities" (Teece et al., 1997), for they involve the ability to learn from experience and to adapt to rapidly changing offshoring and outsourcing environments and opportunities. For example, they should allow companies to shift activities from different locations, to set up and integrate new locations, and to collaborate with new external partners worldwide. In short, these organizational capabilities support companies in using S&E talent at globally dispersed locations. As will become clearer below, ICT *does* play a major role in the application of these capabilities; however, it is important to understand advances in ICT as a facilitator rather than as an organizational capability that drives offshoring decisions.

Recruiting, Developing, and Retaining Talent Globally

To succeed in the emerging global race for high-tech talent, companies need to develop strategies for recruiting, developing, and retaining talent globally. Because of herd effects, many companies adopt offshoring by following the pack, investing in hot-spot locations, such as Bangalore or Shanghai, to access seemingly unlimited pools of S&E talent. Other companies avoid these hot spots and invest in second-tier locations that provide access to talent at lower cost and, more important, avoid the high turnover associated with tight labor markets in hot-spot locations. However, due to the high variance in the quality of graduates and their lack of work experience, the actual qualifications of many of these engineers and technicians may be more difficult to evaluate and often are considered to be below the requirements of Western companies (Farrell et al., 2006).

In response to this institutional constraint (Oliver, 1991), some companies have entered into strategic alliances with local universities and technical institutes to qualify talent for their particular needs and to secure access to these talent pools in the long run. The German automotive supplier Continental, for example, has founded "Continental Universities" in various locations (e.g., Mexico City and Sibiu, Romania). These are joint venture training programs with local technical institutes that involve customization of graduate training programs for Continental requirements and establish the Continental brand as a local S&E company. Similarly, Emerson has established joint training programs with technical institutes in Qindao, China, and Manila, the Philippines. In turn, some universities in offshore locations have learned how to recruit multiple Western corporate partners and sponsors to establish customized programs. For example, the Tong Ji University in Shanghai has established partnerships with a number of German companies in the field of engineering. In addition, companies are making increasing use of specialized placement agencies, especially in order to staff positions that require

experienced individuals. All these players—big investors, universities, and talent agencies—contribute and partly compete for the further development, segmentation, and accessibility of global talent pools.

However, initial access to talent is not sufficient to stay competitive. As noted above, experienced companies see managing of employee turnover as a major strategic challenge (see Figure 5). This indicates that companies are still in the process of experimenting with and developing global career programs and incentive systems that integrate offshore talent into their global workforce (Deloitte, 2004). Integration, however, should not be understood narrowly as internal integration. For many highly skilled S&E specialists, pursuing a career within the organizational boundaries of one particular company may be less attractive than working on projects for different employers on a temporary basis (Barley & Kunda, 2004). Like software communities in Silicon Valley (Saxenian, 1996) and creative communities in media regions (Grabher, 2004), offshore communities of S&E talent are likely to form beyond the boundaries of any particular firm, facilitating information and knowledge transfer and sharing within and between vendors and clients. Careers may be pursued within local and global S&E communities and interorganizational networks (Jones, 1996) rather than within any particular organization. This may change the way "employee turnover" is perceived in fundamental ways. Rather than prevent employees from leaving the company, recruiting them *repeatedly* for specific projects may become a viable option.

Coordinating Far-Flung Innovation Activities

As the ORN survey findings indicated, many companies are struggling with operational efficiency and loss of managerial control, in particular when it comes to offshoring higher skilled activities. Some companies, such as Accenture, SAP, Emerson, and IBM, have implemented so-called "global innovation networks" that are designed to facilitate knowledge-sharing and collaboration across geographic boundaries. These networks connect R&D labs and local teams in different countries (e.g., France, Germany, and India) and serve as social infrastructures for diffusing knowledge from local hubs of innovation. Web-based knowledge management systems and collaborative technologies play an important role in building up global innovation networks within and between organizations. However, it is collaborative skills (Scheibe et al., 2006), effective collaboration in international teams (Subramaniam & Venkatraman, 2005), intelligent incentive structures, a corporate culture of competing for innovation, and the ability to *use* Web-based collaborative technologies effectively that make these networks work. Research shows that large companies in particular cling to using conventional media, e.g., e-mail and telephone, rather than sophisticated rich-media tools (Cummings, 2007; El-Shinnawy & Markus, 1998). The organic adoption of advanced ICT depends on the ability of users to appropriate the technology in diverse contexts of collaboration (El-Shinnawy & Markus, 1998; Orlikowski, 1992). Normative and mimetic isomorphic pressures (DiMaggio & Powell, 1983) also play a role: In particular, practices of competitors and customer demands and expectations may further drive companies to signal their technological capability by using these collaborative tools.

Collaborating with External Partners

Often, IT and Business Process Outsourcing (BPO) are associated with large third-party service providers, such as Flextronics, Infosys, and Wipro (Engardio & Einhorn, 2005), that primarily provide IT and business process outsourcing (BPO) services (Engardio & Einhorn, 2005). However, the recently completed first annual (2007) ORN service provider survey suggests that, after IT, new product development has become the second most frequently provided type of service. Small providers (fewer than 500 employees), in particular, specialize in offering product development functions from various locations around the world. One example of such a specialized innovation service provider is Gen3, which has developed capabilities to access and manage external pools of experts around the world (but especially in Russia) and to undertake entire new product and process development projects for client companies. As those specialized providers develop, client companies

need to reexamine their in-house capability to develop new products and services. In the near future, many more companies may take advantage of the specialized capabilities of external service providers. In order to do so, they need to develop capabilities to assess the service quality and reliability of service providers as well as their capacity to manage and employ talent on client projects. Alternatively, some clients might prefer to poach staff from external providers and manage them in their own captive organizations. Case studies suggest that a variety of service delivery arrangements are emerging where client companies and service providers collaborate in different ways. This, in turn, might contribute to the development of innovation networks involving client companies, third-party service providers, and individual users and experts who span different S&E clusters and create new geographies of innovation (Ernst, 2005).

As innovation processes become increasingly open and distributed (Chesbrough, 2003; Coombs et al, 2003) and as communities of practice (Brown & Duguid, 1991) globalize within and between firms, new organizational and managerial capabilities for managing innovation and knowledge sharing processes need to be developed. The disintermediation and externalization of innovation processes through outsourcing and remotely dispersed R&D groups and laboratories has diffused through many industries, although at varying rates, in the last decade or two (e.g., Howells, 1990, 1995; Quinn, 2000). The challenge for offshoring firms is to develop practices for managing knowledge interfaces and for transferring and reconnecting knowledge across spatial and organizational boundaries. Innovative routines and processes may over time become more codified or formalized, but may still require face-to-face contact for facilitating and deepening the transfer of routines, processes, and quality standards. Companies need to be prepared to rotate key people from domestic to offshore engineering and research facilities in order to monitor and ensure effective transfer of existing routines and institute necessary protocols for communication between the home and offshore teams. Furthermore, as companies start to offshore higher end product development, either in-house (captive organization offshore) or outsourced to third-party providers, practices and routines for reverse knowledge transfer and flow need to be developed. For example, according to 2006 ORN survey results, some companies have experimented with hosting S&E staff from offshore locations to liaise and integrate with their counterparts in the home country. Similarly, new interface management positions (e.g., boundary spanners) and supportive innovation and knowledge-sharing cultures need to develop globally (e.g., Rullani, 2007) to facilitate collaboration and promote "swift trust" (Meyerson et al., 1996) between globally dispersed individuals and teams.

Implications for Corporate Strategy and Policy-Making

The main objective of this paper has been to advance a more nuanced view of factors and forces that explain recent offshoring decisions aimed at sourcing and using science and engineering (S&E) talent globally (see Figure 4). This is a new but strategically important and growing trend that needs to be understood in terms of longer historical, path-dependent, and coevolutionary developments, and as part of a transformational process that has only just begun. This is because offshoring of higher skilled processes is still in its early-adopter stage. However, unlike in the past, because of the rapid growth in the demand for talent, companies increasingly consider it a strategic necessity to go where the talent is. This is mainly a result of the difficulties companies encounter in recruiting talent domestically and of economic advances in the developing world. While the pool of domestic S&E talent in the Western world has been shrinking due to a declining interest in S&E careers, aging of the population, and inadequate high-school level training in math and science, new S&E clusters providing highly skilled talent for particular functions, such as IT or product development, are emerging and are attracting Western clients across industries. The emergence of these clusters coincides with a shift in the global talent pool. Facilitated by population and economic growth and major investments in education and national innovation sys-

tems, emerging economies, such as India and China, have managed to provide more attractive career opportunities and to gradually "reverse" the brain drain. The emergence of third-party service providers is another factor that contributes to the growth and attractiveness of new S&E clusters. These new players, as part of their strategy to move up the value chain, are also competing for talent as they set out to build their global capacity for partnering in innovation projects. This new trend is also stimulated by the appreciation of the local currency against the currencies of some Western countries.

However, offshoring decisions are also affected by new challenges and the need to evolve new firm-level capabilities. In particular, ORN findings have suggested that the more experienced companies are learning that managing the risks of wage inflation and employee turnover requires the development of new organizational capabilities for recruiting, managing, and retaining global talent more effectively. Many companies are also in the process of developing capabilities that enable them to more effectively coordinate far-flung innovation activities, partly using Web-based collaborative technologies. As a result, according to ORN findings, the more experienced companies are becoming less concerned with operational efficiency (Figure 5). Finally, experienced companies seem to have learned how to collaborate with or manage third-party service providers and to restructure their organizations and processes in ways that have lessened their concern with the loss of managerial control. These capabilities and challenges, however, need to be seen as coevolving with new opportunities, such as the rise of new locations in the offshoring space and the emergence of new specialized external service providers. Therefore, the need to continuously keep pace with developing new offshoring capabilities is a challenge that companies will face as they continue to engage in offshoring and globalizing their S&E activities.

These dynamics have important implications for company-level strategies. Cisco, for example, in a bold and audacious move, has recently established Cisco Center East in Bangalore, India, as the new Cisco corporate headquarters for company-wide innovation, under the leadership of the first chief globalization officer of the company (the first ever for a U.S. company). Their former San Jose–based U.S. headquarters is now referred to as Cisco Center West, reflecting its new role in the corporation. This example illustrates a coming trend: According to the latest findings of the ORN survey, more and more companies are formulating and disseminating corporate-wide strategies for guiding outsourcing and offshoring decisions at the business unit and function level and are integrating offshoring decisions into the overall corporate strategy. Early on, offshoring and offshore outsourcing was primarily a bottom-up phenomenon. Only recently have companies begun to realize the strategic opportunities for relocating and reorganizing their S&E operations as well as other applications such as BPO and IT infrastructure. As companies ramp up offshoring of S&E activities in geographically dispersed locations, they are gradually transforming formerly centralized S&E operations into globally dispersed ones. Over time, relocation decisions have become more interdependent and embedded within a growing and shifting network of globally dispersed operations. Rather than guiding decisions to shift processes from A to B, companies are beginning to develop network strategies that integrate multinode configurations of S&E capabilities, involving location advantages and specialization effects, and inter-firm relationships with a portfolio of globalizing external service providers and on-demand staffing (talent) agencies.

These trends also have important policy implications. To date, most policy-oriented studies have focused solely on the domestic talent supply and its impact on the competitiveness of the U.S. (e.g., Freeman, 2006; Lowell & Salzman, 2007). However, many policy-makers in the U.S. and Western Europe largely ignore or underestimate the dynamics involved. In particular, the interdependencies of changing national policies, macroeconomic conditions, and firm-level strategies in advanced and emerging economies are often overlooked. Single policies directed in isolation to improving national education systems or toward establishing targeted visa programs cannot on their own redress the domestic supply of S&E

talent. Not only have the U.S. and countries in Western Europe not made progress on introducing policies and incentives intended to reverse the trend of fewer young people selecting S&E careers, but they have also largely failed to attract sufficient highly skilled talent from abroad. At the same time, emerging economies have begun to successfully implement national policies and tax incentives designed to "reverse the brain drain". In addition, national and regional innovation systems (Howells, 1999; Nelson, 1993) at offshore destinations are rapidly evolving their infrastructures and institutions, partly based on and partly deviating from Western models, in order to continue to attract an ever-increasing number of foreign operations, resulting in virtuous cycles that will make the destinations even more attractive. At the same time, it appears that research and innovation policies in the home countries of offshoring companies have not kept up with the latest global developments and seem to be struggling to counteract the relocation of high-end innovation activities. The demarcation between developed and developing countries is becoming increasingly narrow and the interdependencies of education, business, and innovation systems ever tighter, as highlighted in the discussion of India and China. Western policy-makers need to become more aware of these interdependencies, not least in order to better anticipate effects and consequences of their policy decisions. Moreover managers of Western companies need to become more involved in the discussions and formulation of national policies affecting technology policies (Nelson, 1995) and other policy discussions and interventions at the international level that may affect the outcome of their offshoring strategies and plans.

Although it is perhaps beyond the scope of this paper, national policy-makers in Western economies need to evolve more collaborative than purely domestic strategies in order to better compete for talent and high-end investment. Such a perspective would recognize the reality that emerging economies are likely to experience a shortage of S&E talent in the medium term and that, in the long run, opportunities for *any* economy to develop specialized expertise and skill sets *by itself* are limited. In face of this challenge, many educational and research institutions in the U.S. and Western Europe are already setting up partnerships and exchange programs with counterparts in emerging economies to get better access to talent and expertise. Also, national innovation systems are becoming increasingly interlinked (e.g., Carlsson, 2006), and "networks" of clusters and supporting institutions across the world seem to develop that facilitate "brain circulation" and the emergence of a lively cross-national S&E community. As a result, those countries that heavily engage in forming such networks may build up a competitive advantage over those pursuing a purely domestic strategy.

References

Abramowsky, L., & Griffith, R. (2006). Outsourcing and offshoring of business services: How important is ICT? *Journal of the European Economic Association, 4*(2–3), 594–601.

Amiti, M., & Wei, S.-J. (2004). Demystifying outsourcing: The numbers do not support the hype over job losses. *Finance & Development, 41*(4), 36–39.

Angeli, F., & Grimaldi, R. (2007). *The evolution of offshoring activities: The role of resource endowments and dynamic capabilities in addressing new business opportunities*. Paper presented at the Duke CIBER Research Conference and Workshop on Offshoring, Cary, NC.

Antràs, P., & Helpman, E. (2004). Global sourcing. *Journal of Political Economy, 112*(3), 525–580.

Athreye, S. (2005). The Indian software industry and its evolving service capability. *Industrial and Corporate Change, 14*(3), 393–418.

A. T. Kearney (2004). *Making offshore decisions: A. T. Kearney's 2004 offshore location attractiveness index* (A. T. Kearney Report). Chicago: A. T. Kearney, Inc.

Bajpaj, N., Arora, R., & Khurana, H. (2004). *Global services sourcing: Issues of cost and quality* (CGSD Working Paper No. 16). New York: Center on Globalization and Sustainable Development.

Barley, S. R., & Kunda, G. (2004). *Gurus, hired guns, and warm bodies: Itinerant experts in a knowledge economy*. Princeton, NJ: Princeton University Press.

Beshouri, C. P., & Farrell, D. (2005). *The Philippines' offshoring opportunity*. Washington, DC: McKinsey.

Blinder, A. S. (2006). Offshoring: The next industrial revolution? *Foreign Affairs, 85*(2), 113–128.

Bresnahan, T., Gambardella, A., & Saxenian, A. (2001). "Old economy" inputs for "new economy" outcomes: Cluster formation in the new Silicon Valleys. *Industrial and Corporate Change, 10*(4), 835–860.

Brown, J. S., & Duguid, P. (1991). Organizational learning and communities-of-practice: Toward a unified view of working, learning, and innovation. *Organization Science, 2*(1), 40–57.

Buckley, C. (2004, September 13). Let a thousand ideas flower: China is a new hotbed of research. *New York Times*, p. C1.

Bunyaratavej, K., Hahn, E. D., & Doh, J. P. (2007). International offshoring of services: A parity study. *Journal of International Management, 13*, 7–21.

Butz, W. P., Bloom, G. A., Gross, M. E., Kelly, T. K., Kofner, A., & Rippen, H. E. (2003). *Is there a shortage of scientists and engineers? How would we know?* (Rand Issue Paper IP-241-OSTP). Retrieved July 30, 2008, from http://www.rand.org/pubs/issue_papers/IP241

Cantwell, J. (1995). The globalisation of technology: What remains of the product cycle model. *Cambridge Journal of Economics, 19* (1), 155–174.

Carlsson, B. (2006). Internationalization of innovation systems: A survey of the literature. *Research Policy, 35*, 56–67.

Cervantes, M. (2003). Scientists and engineers: Crisis, what crisis? *The OECD Observer*, December, 37.

Chanda, R., & Sreenivasan, N. (2005). India's experience with skilled migration. In C. Kuptsch & E. F. Pang (Eds.), *Competing for Global Talent* (pp. 215–256). Geneva, Switzerland: ILO International Institute for Labour Studies.

Chesbrough, H. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Boston: Harvard Business School Press.

Coombs, R., Harvey, M., & Tether, B. (2003). Analyzing distributed processes of provision and innovation. *Industrial and Corporate Change, 12*(6), 1125–1155.

Cummings, J. (2007). *Fostering innovation in organizations through geographically dispersed teams and networks*. Paper presented at the Duke CIBER Research Conference and Workshop on Offshoring, Cary, NC.

Delios, A., and Henisz, W. J., (2003). Political hazards and the sequence of entry by Japanese firms. *Journal of International Business Studies, 34*(3), 227–41.

Deloitte. (2004). It's 2008: *Do you know where your talent is? Why acquisition and retention strategies don't work* (Deloitte Research Study). New York: Deloitte Development LLC.

DeSanctis, G., & Poole, M. S. 1994. Capturing the complexity in advanced technology use: Adaptive structuration theory. *Organization Science, 5*(2), 121–147.

Dicken, P. (2007). *Global shift: Mapping the changing contours of the world economy* (5th ed.). London: Sage.

DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review, 48*(2), 147–160.

Disher, C., & Lewin, A.Y. (2007). *The power link between innovation and the globalization of talent*. Paper presented at the 2007 IAOP World Outsourcing Summit, Las Vegas, NV.

Dodgson, M., Gann, D., & Salter, A. (2006). The role of technology in the shift towards open innovation: The case of Procter & Gamble. *R&D Management, 36*(3), 333–346.

Doh, J. P. (2005). Offshore outsourcing: Implications for international business and strategic management theory and practice. *Journal of Management Studies, 42*(3), 695–704.

Dossani, R., & Kenney, M. (2006). Reflections upon "Sizing the Emerging Global Labor Market." *Academy of Management Perspectives, 20*(4), 35–41.

Dossani, R., & Kenney, M. (2007). The next wave of globalization: Relocating service provision to India. *World Development, 35*(5), 772–791.

European Community. (2006). Putting knowledge into practice: A broad-based innovation strategy for the EU. *COM (2006)*, 502(13.9.2006).

El-Shinnawy, M., & Markus, L. (1998). Acceptance of communication media in organizations: Richness or features? *IEEE Transactions on Professional Communication, 41*(4), 242–253.

Engardio, P., Bernstein, A., & Kripalani, M. (2003, February 3). Is your job next? *Business Week*, 50–60.

Engardio, P., & Einhorn, B. (2005, March 21). Outsourcing innovation. *Business Week*, 85–94.

Enright, M. (2000). Regional clusters and multinational enterprises: Independence, dependence or interdependence? *International Studies of Management and Organization, 30*(2), 114–138.

Erber, G., & Sayed-Ahmed, A. (2005). Offshore outsourcing: A global shift in the present IT industry. *Intereconomics, 40*(2), 100–112.

Ernst, D. (2002). Global production networks and the changing geography of innovation systems. Implications for developing countries. *Economics of Innovation and New Technology, 11*(6), 497–523.

Ernst, D. (2005). Complexity and internationalization of innovation: Why is chip design moving to Asia? *International Journal of Innovation Management*, 9(1), 47–73.

Farrell, D., Laboissière, M. A., & Rosenfeld, J. (2006). Sizing the emerging global labor market: Rational behavior from both companies and countries can help it work more efficiently. *Academy of Management Perspectives, 20*(4), 23–34.

Florida, R. (1997). The globalization of R&D: Results of a survey of foreign-affiliated R&D laboratories in the USA. *Research Policy, 26*, 85–103.

Florida, R. (2005). *The flight of the creative class. The new global competition for talent*. New York: HarperCollins.

Freeman, R. (2006). *Does globalization of the scientific/engineering workforce threaten U.S. economic leadership?* (NBER Innovation Policy & the Economy Working Paper). Cambridge, MA: National Bureau of Economic Research.

Frymire, B. (2006, October 7). The search for talent. *The Economist, 381*(8498), 11.

Gainey, T., & Klaas, B. S. (2003). The outsourcing of training and development: Factors affecting client satisfaction. *Journal of Management, 29*(2), 207–229.

Garner, A. (2004). Offshoring in the service sector: Economic impact and policy issues. *Economic Review 3* (Federal Reserve Bank of Kansas City), 5–37.

Gereffi, G. (2005). *The new offshoring of jobs and global development* (ILO Social Policy Lectures). Geneva: International Institute for Labor Studies and International Labor Organization.

Global Insight. (2004). *Executive summary: The comprehensive impact of offshore IT software and services outsourcing on the U.S. economy and the IT industry* (Report sponsored by Information Technology Association of America). Lexington, MA: Global Insight, Inc.

Grabher, G. (2004). Architectures of project-based learning: Creating and sedimenting knowledge in project ecologies. *Organization Studies, 25*(9), 1491–1514.

Granstrand, O., Håkanson, L., & Sjölander, S. (1992). *Technology management and international business: Internationalization of R&D and technology*. Chichester, England: John Wiley and Sons.

Gu, M., & Tse, E. (2007). *The contextual effect on innovation: A conceptual framework for understanding offshore innovative activities in China*. Paper presented at the Duke CIBER Research Conference and Workshop on Offshoring, Cary, NC.

Hansen, F. (2006). The great global talent race. *Workforce Management, 85*(7), 1–23.

Harrison, A. E., & McMillan, M. S. (2006). Dispelling some myths about offshoring. *Academy of Management Perspectives, 20*(4), 6–22.

Helper, S., & Khambete, S. (2005). *Off-shoring, interfaces, and collaboration across the supply chain: A case study in automotive product development* (Working paper prepared for the International Motor Vehicle Program). Cleveland, OH: Case Western Reserve University.

Henley, J. (2006). Outsourcing the provision of software and IT-enabled services to India. *International Studies of Management & Organization, 36*(4), 111–131.

Holcomb, T. R., & Hitt, M. A. (2007). Toward a model of strategic outsourcing. *Journal of Operations Management, 25*(2), 464–481.

Holm, U., & Pedersen, T. (Eds.). (2000). *The emergence and impact of MNC centres of excellence: A subsidiary perspective*. London: Macmillan.

Howells, J. (1990). The location and organisation of research and development: New horizons. *Research Policy, 19*(2), 133–146.

Howells, J. (1995). Going global: The use of ICT networks in research and development. *Research Policy, 24*(2), 169–184.

Howells, J. (1999). Regional systems of innovation? In D. Archibugi, J. Michie, & J. Howells (Eds.), *Innovation systems in a global economy* (pp. 67–93). Cambridge, England: Cambridge University Press.

Huang, Y., & Khanna, T. (2003). Can India overtake China? *Foreign Policy, 137*(July/August), 74–81.

Intarakumnerd, P., Chairatana, P.-a., & Tangchitpiboon, T. (2002). National innovation system in less successful developing countries: The case of Thailand. *Research Policy, 31,* 1445–1457.

Jensen, P. D. Ø., & Pedersen, T. (2007). *Whether and what to offshore*. Paper presented at the Duke CIBER Research Conference and Workshop on Offshoring, Cary, NC.

Jones, C. (1996). Careers in project networks: The case of the film industry. In M. B. Arthur & D. M. Rousseau (Eds.), *The boundaryless career: A new principle for a new organizational era* (pp. 58–75). New York: Oxford University Press.

Kedia, B. L., & Lahiri, S. (2007). International outsourcing of services: A partnership model. *Journal of International Management, 13,* 22–37.

Kenney, M., & Florida, R. (1994). The organization and geography of Japanese R&D: Results from a survey of Japanese electronics and biotechnology firms. *Research Policy, 23*(3), 305–323.

Krishnaswamy, C. R., & Pashley, M. M. (2007). *Attitudes towards offshore outsourcing and U.S. bank risks*. Paper presented at the Duke CIBER Research Conference and Workshop on Offshoring, Cary, NC.

Kshetri, N. (2007). Institutional factors affecting offshore business process and information technology outsourcing. *Journal of International Management, 13,* 38–56.

Kuemmerle, W. (1999). The drivers of foreign direct investment into research and development: An empirical investigation. *Journal of International Business Studies, 30*(1), 1–24.

Kumar, N. (1996). Intellectual property protection, market orientation and location of overseas R&D activities by multinational enterprises. *World Development, 24*(4), 673–688.

Kuptsch, C., & Pang, E. F. (Eds.). (2005). *Competing for global talent*. Geneva, Switzerland: ILO International Institute for Labour Studies.

Leiblein, M. J. (2003). The choice of organizational governance form and performance: Predictions from transaction cost, resource-based, and real options theories. *Journal of Management, 29*(6), 937–961.

Leiblein, M. J., & Miller, D. J. (2003). An empirical examination of transaction- and firm-level influences on the vertical boundaries of the firm. *Strategic Management Journal, 24*(9), 839–859.

Levina, N. (2007). *The impact of organizational and national boundaries on offshore collaboration: Program managers as boundary spanners*. Paper presented at the Duke CIBER Research Conference and Workshop on Offshoring, Cary, NC.

Lewin, A. Y., & Couto, V. (2007). *Next generation offshoring: The globalization of innovation* (Duke University CIBER/Booz Allen Hamilton Report). Durham, NC: Duke CIBER.

Lewin, A. Y., Massini, S., & Peeters, C. (2008). Why are companies offshoring innovation? The emerging global race for talent. *Journal of International Business Studies*, forthcoming.

Lewin, A. Y., & Peeters, C. (2006a). Offshoring work: Business hype or the onset of fundamental transformation? *Long Range Planning, 39*(3), 221–239.

Lewin, A. Y., & Peeters, C. (2006b). The top-line allure of offshoring. *Harvard Business Review, 84*(3), 22–24.

Lieberman, J. I. (2004). *Offshore outsourcing and America's competitive edge: Losing out in the high technology R&D and services sectors* (U.S. Senate Report). Washington, DC: U.S. Senate.

Lieberthal, K., & Lieberthal, G. (2003). The great transition. *Harvard Business Review, 81*(10), 70–81.

Lowell, B. L., & Salzman, H. (2007). *Into the eye of the storm: Assessing the evidence on science and engineering education,*

quality, and workforce demand (Urban Institute Working Paper). Washington, DC: Urban Institute.

MacDuffie, J. P. (2007). *Modularity and the geography of innovation*. Paper presented at the 2007 INFORMS Annual Meeting, Seattle.

Mankiw, N. G., & Swagel, P. (2006). *The politics and economics of offshore outsourcing* (NBER Working Paper No. 12398). Cambridge, MA: National Bureau of Economic Research.

Manning, S. (2008). Customizing clusters: On the role of Western MNCs in the formation of science & engineering clusters in emerging economies. *Economic Development Quarterly,* forthcoming.

Manning, S., Sydow, J., & Windeler, A. (2007). *The art of active embedding: How automotive suppliers manage to do engineering in emerging economies*. Paper presented at the 2007 Annual Meeting of the Academy of Management, Philadelphia.

Marin, D. (2005). *A new international division of labor in Europe: Outsourcing and offshoring to Eastern Europe* (GESY Working Paper). Mannheim: University of Mannheim, GESY.

Markusen, J. R. (2005). *Modeling the offshoring of white-collar services: From comparative advantage to the new theories of trade and foreign direct investment* (CEPR Discussion Paper No. 5408). Boulder: University of Colorado, CEPR.

Marshall, A. (1920). *The principles of economics* (8th ed.). London: Macmillan.

Martin, P. L. (2005). Competing for global talent: The US experience. In C. Kuptsch & E. F. Pang (Eds.), *Competing for global talent* (pp. 87–106). Geneva, Switzerland: ILO International Institute for Labour Studies.

Maskell, P., Pedersen, T., Petersen, B., & Dick-Nielsen, J. (2006). *Learning paths to offshore outsourcing: From cost reduction to knowledge seeking* (CBS Center for Strategic Management and Globalization Working Paper 13/2006). Copenhagen, Denmark: Copenhagen Business School.

Massini, S., Lewin, A. Y., & Manning, S. (2008). *Offshoring innovation and the emergence of new organizational capabilities: A co-evolutionary research perspective* (Duke CIBER Working Paper). Durham, NC: Duke CIBER.

Mehta, A., Armenakis, A., Mehta, N., & Irani, F. (2006). Challenges and opportunities of business process outsourcing in India. *Journal of Labor Research, 27,* 323–338.

Meyerson, D., Weick, K. E., & Kramer, R. M. (1996). Swift trust and temporary groups. In R. M. Kramer & T. R. Tyler (Eds.), *Trust in organizations* (pp. 166–195). Thousand Oaks, CA: Sage.

Nelson, R. R. (1993). *National innovation systems: A comparative analysis*. New York: Oxford University Press.

Nelson, R. R. (1995). Why should managers be thinking about technology policy? *Strategic Management Journal, 16*(8), 581–588.

National Science Foundation. (2006). *Science and Engineering Indicators 2006*. Arlington, VA: NSF Division of Science Resources Statistics.

Oliver, C. (1991). Strategic responses to institutional processes. *Academy of Management Review, 16*(1), 145–179.

Olsen, K. B. (2006). *Productivity impacts of offshoring and outsourcing: A review* (OECD STI Working Paper 2006/1). Paris: OECD Directorate for Science, Technology and Industry.

Orlikowski, W. J. (1992). The duality of technology: Rethinking the concept of technology in organizations. *Organization Science, 3*(3), 398–427.

Patel, P., & Pavitt, K. (1991). Large firms in the production of the world's technology: An important case of "non-globalization." *Journal of International Business Studies, 22*(1), 1–21.

Patel, P., & Vega, M. (1999). Patterns of internationalisation of corporate technology: Location vs. home country advantages. *Research Policy, 28*(2/3), 145–155.

Patibandla, M., & Petersen, B. (2002). Role of transnational corporations in the evolution of a high-tech industry: The case of India's software industry. *World Development, 30*(9), 1561–1577.

Pearce, R. D. (1999). Decentralized R&D and strategic competitiveness: Globalized approaches to generation and use of technology in MNEs. *Research Policy, 28,* 157–178.

Porter, M. (2000). Location, competition, and economic development: Local clusters in a global economy. *Economic Development Quarterly, 14*(1), 15–34.

Pyndt, J., & Pedersen, T. (2006). *Managing global offshoring strategies: A case approach*. Copenhagen, Denmark: Copenhagen Business School.

Quinn, J. B. (2000). Outsourcing innovation: The new engine of growth. *Sloan Management Review, 41*(4), 13–28.

Reddy, P. (1997). New trends in globalization of corporate R&D and implications for innovation capability in host countries: A survey from India. *World Development, 25*(11), 1821–1837.

Ren, Z. J., & Zhou, Y.-P. (2007). *Call center outsourcing: Coordinating staffing level and service quality*. Paper presented at the Duke CIBER Research Conference and Workshop on Offshoring, Cary, NC.

Rullani, F. (2007). *Explaining leadership in open source software projects*. Paper presented at the 13th Annual Organization Science Winter Conference, Steamboat Springs, CO.

Salzman, H. (2007). *Globalization of R&D and innovation: Implications for U.S. STEM workforce and policy* (Testimony before the U.S. House Subcommittee on Technology and Innovation, published by the Urban Institute). Washington, DC: Urban Institute.

Saxenian, A. (1996). Beyond boundaries: Open labor markets and learning in Silicon Valley. In M. B. Arthur & D. M. Rousseau (Eds.), *The boundaryless career: A new employment principle for a new organizational era* (pp. 23–39). New York: Oxford University Press.

Scheibe, K. P., Menneke, B. E., & Zobel, C. W. (2006). Creating offshore-ready IT professionals: A global perspective and strong collaborative skills are needed. *Journal of Labor Research, 17*(3), 275–290.

StepStone. (2006). *Recruitment trends 2006* (StepStone Survey). Retrieved July 31, 2008, from http://www.stepstone.de/ueberuns/presse/survey2006_rectrends02.html

Subramaniam, M., & Venkatraman, N. (2001). Determinants of transnational new product development capability: Testing the influence of transferring and deploying tacit overseas knowledge. *Strategic Management Journal, 22*(4), 359–378.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509–533.

United Nations Conference on Trade and Development. (2005). *Prospects for foreign direct investment and the strategies of transnational corporations 2005–2008* (United Nations Report). Geneva: UNCTAD.

van Ark, B., Guillemineau, C., & McGuckin, R. H. (2006). *U.S. productivity growth slowing sharply as emerging markets catch up* (The Conference Board Executive Action Report #176). New York: The Conference Board.

Volberda, H. W., & Lewin, A. Y. (2003). Co-evolutionary dynamics within and between firms: From evolution to co-evolution. *Journal of Management Studies, 40*(8), 2111–2136.

Zhou, P., & Leydesdorff, L. (2006). The emergence of China as a leading nation in science. *Research Policy, 35,* 83–104.

Zweig, D. (2005). Learning to compete: China's efforts to encourage a "reverse brain drain." In C. Kuptsch & E. F. Pang (Eds.), *Competing for Global Talent* (pp. 187–214). Geneva, Switzerland: ILO International Institute for Labour Studies.