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Why Are Companies Offshoring Innovation? The Emerging Global Race for Talent

A. Y. Lewin, S. Massini and C. Peeters

This paper empirically studies the determinants of firms' decision to offshore product development activities (i.e. R&D, product design and engineering services). A logit model is estimated using survey data from the Offshoring Research Network on offshore implementations initiated by US firms between 1990 and 2006. It relates the probability of offshoring product development to differences in companies' strategic objectives (managerial intentionality), past experience (path dependence), and in environmental factors. The results show that offshoring of product development is partially explained by the emerging shortage of high skilled technical talent in the US, which drives the need to access talent globally. The data also suggest that firms use offshore cost savings opportunities to improve the efficiency of the innovation process, although not through labor arbitrages. Finally, increasing speed to market is another major reason underlying product development offshoring decisions.

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Keywords: offshoring, innovation, product development, global talent.

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Université Libre de Bruxelles – Solvay Business School – Centre Emile Bernheim
ULB CP 145/01 50, avenue F.D. Roosevelt 1050 Brussels – BELGIUM
e-mail: ceb@admin.ulb.ac.be Tel. : +32 (0)2/650.48.64 Fax : +32 (0)2/650.41.88

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Arie Y. Lewin
Duke University – The Fuqua School of Business
1 Towerview Drive, Box 90120
Durham, NC 27708, USA
Tel. +1 919 660 7654
ayl3@duke.edu

Silvia Massini
Manchester Business School
University of Manchester
Booth Street West, Manchester M15 6PB, United Kingdom
Tel: +44 (0)161 306 8794
Email: silvia.massini@mbs.ac.uk

Carine Peeters
Université libre de Bruxelles – Solvay Business School
ECARES and Centre Emile Bernheim
50 Avenue F.D. Roosevelt CP 145/1
B – 1050 Bruxelles, BELGIUM
Tel: +32 2 650 4462 / 4870
Email: carine.peeters@ulb.ac.be

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Abstract

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1. Introduction

Outsourcing of manufacturing activities to low cost countries is widely practiced and well understood (e.g. Dunning, 1993; Lee, 1986; Vernon, 1966). In comparison, the offshoring of high-value adding white collar activities – pioneered by a few companies in the 1980s - is still a relatively undiffused practice (Amiti and Wei, 2005). However, Dossani and Kenney (2007, p.779) conclude that “in less than six years, services offshoring has evolved from an exotic and risky strategy to a routine business decision”. Of particular interest to this paper are the actions of US companies that are increasingly offshoring higher value added knowledge intensive processes and are restructuring and reorganizing their innovation processes worldwide (Henley, 2006; Levy, 2005). According to Apte et al. (2006) new product development is becoming the fastest growing offshoring segment in India. Ernst (2006) suggests that this growth in innovation offshoring is driven by increased globalization of markets for technology and knowledge workers. However, the exact reasons that lead firms to decide to offshore value-adding innovative activities close to their core business, which conventional wisdom and existing literature (e.g., Patel and Pavitt, 1991) suggests should be kept under tight control, remain to be empirically studied. The present paper contributes towards this goal.

Offshoring refers to the process of sourcing and coordinating tasks and business functions across national borders. Offshoring may include both in-house (captive, or international in-sourcing) and outsourced activities, which are delivered by an external provider – that is from outside the boundaries of the firm. Outsourcing, in turn, may occur both domestically (onshore) and abroad (offshore). Further, offshoring refers to sourcing rather than sales activities, and it supports global or domestic rather than local operations. It is not primarily intended for entering a foreign market nor for supporting the company’s local activities. For example, setting up HR (human resources) 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. Though it used to be limited to simple codified and repetitive tasks, companies are now offshoring increasingly complex and advanced activities requiring more and more qualified workers (Lewin and Peeters, 2006). This trend is enabled by trade liberalization policies, advances in information technologies (Doh, 2005; Levy, 2005; Dossani and Kenney, 2006), and by the ability of companies to dis-intermediate and modularize almost any process, including knowledge creating processes (Sako, 2002; Takeishi, 2002). At the same time, however, according to Farrell *et al*. (2006) and Mehta *et al*. (2006), the organizational structures and processes necessary for coordinating globally dispersed business units and activities, managing knowledge, selecting locations and managing talent offshore represent major managerial challenges that could limit the growth in offshoring.

In this paper, we focus on the offshoring of innovation (both captive and outsourced) and seek to study the factors underlying the evolution of offshoring practices towards global sourcing of talent and rapidly rising trend of offshoring new product development work (i.e. R&D, product design and engineering services). In the early 1980s several leading edge companies such as Texas Instruments, Motorola, and General Electric established technology centers in India and China to secure strategic advantages such as favorable political treatment (Delios and Henisz, 2003) and access to talent. Twenty years later, small entrepreneurial firms are increasingly offshoring new product development because their ability to grow, need to increase speed to market, or simply their survival depend on it (Dixit 2005; Shah 2005; Buchanan, 2006; Rangan and Schumacher, 2006; Dossani and Kenney, 2007). Asia in particular is playing a central role in the growing global innovation networks, as indicated, for example, by the growth in US patents granted to companies in Asia between 1986 and 2003 (Ernst, 2002 and 2006). Major Asian countries in that respect include South Korea, Singapore, China, Taiwan and India. However, Hirshfeld and Schmid's (2005) argue that, although firms in the US and Europe are increasingly attracted to and are exploring new science and engineering clusters in emerging countries, advanced economies are likely to remain at the forefront of innovation activities, at least in the foreseeable future (Manning *et al*., 2008).

In order to study the determinants of firms' decision to offshore product development activities, we use original survey data from the Offshoring Research Network (ORN) on 880 offshore implementations initiated by US firms between 1990 and 2006. The ORN is an ongoing multi-year international project tracking the offshoring of administrative and technical work by companies in the US and Europe. In contrast to other datasets, it allows studying offshoring decisions at the level of individual offshore implementations, and not at more aggregate firm or industry level.

Responding to Hutzschenreuter *et al*. (2007) call for further integrating managerial intentionality into international business strategy and internationalization research, our empirical approach models managerial intentionality, path dependence and environment as factors affecting the decisions to offshore new product development (NPD) functions and processes. The analysis studies whether offshoring of product development can be explained in part by the emerging shortage of highly skilled technical talent in the US, which drives the need to access talent globally. We argue that the diminishing attractiveness of science and engineering (S&E) careers (as indicated by the decline in US nationals earning advanced degrees in S&E) combined with the 2003 cut back in H1B visa[1] quota are key factors underlying this trend. The analysis also seeks to clarify the role of offshore labor cost savings opportunities in improving the efficiency of the innovation process. We argue that the possibility to access equally qualified workers at lower cost does influence companies' decision to offshore, but compared to other functions, labor arbitrage objectives would be less important in the decision to offshore product development. Other strategic drivers potentially influencing product development offshoring decisions that the model tests for include the importance of increasing speed to market to foster business growth, and competitive pressures. Finally, we investigate the role of companies' past experience in determining their offshoring decisions.

[1] The H1B is a non immigrant visa category for temporary workers in specialty occupations requiring the theoretical and practical application of a body of specialized knowledge. H1B applicants must hold a bachelor's degree or the equivalent in the specific specialty (e.g., engineering, mathematics, physical sciences, computer sciences, medicine and health care, education, biotechnology, business specialties, etc.). Each fiscal year, the US Congress sets a cap on H1B admissions. The H1B visa is the main channel for US companies to employ foreign S&E workers in the US.

In the section that follows we review the relevant literature and evidence, and discuss the research questions pertaining to the role of environmental factors, managerial strategic objectives and firm past experience as determinants of firm decisions to offshore NPD functions and processes. Following a brief introduction on the Offshoring Research Network project, section 3 describes the data used in this study and provides the methodological details. Then we present the regressions results. The discussion section interprets the empirical findings in the broader context of growing globalization of human capital. This is followed by some concluding remarks.

2. Literature review and theoretical framework

Three types of arguments have traditionally been used in the literature to explain firm level internationalization processes. First, the market approach argues that firms' internationalization is driven by the exploitation on a larger market, of a firm specific advantage in one activity (Hymer, 1976). Second, the internalization approach relies on the transaction cost theory (Williamson, 1975 and 1981) to suggest that multinationals internalize in multiple locations the markets for their knowledge-based assets (Buckley and Casson, 1976). Finally, Dunning's (1980) OLI approach suggests that FDIs are explained by the combination of firm-specific, location-specific and internalization advantages. Within that literature, offshoring can be seen as a new form of internationalization by which firms disaggregate their value chain across multiple-locations, potentially externalizing portions of it to third party service providers.

In the past, researchers have examined the sequence over time of FDI in multiple host countries. Horst (1972) argues that multinational enterprises commonly expand through a series of host countries starting with the ones that are geographically closest (see also Rugman and Verbeke, 2004). Earlier studies have shown that locating of R&D outside the home country by large MNEs is not a recent phenomenon (e.g. Lall, 1979; Granstrand et al., 1992; Kenney and Florida, 1994; Pearce, 1999). Cantwell (1995) for instance showed that back in the 1930s, the largest European and US firms carried out about 7% of their total R&D at locations abroad. However, since the 1960s this figure has been steadily rising, particularly in technologically intensive industries. Kuemmerle (1999b) shows that in 1965, 32 multinational firms in his paper carried out 6.2% of their R&D efforts outside of their home country boundaries, while in 1995 the corresponding figure was 25.8%. But with the exception of large MNEs in small countries, which have historically expanded their R&D activities offshore since World War II (Cantwell, 1995), the home country remained the most important single location for R&D (Patel and Pavitt, 1991) and the organizational form was one of own and control, and that in the 1990s FDIs in R&D occurred primarily between a small number of highly industrialized countries (Florida, 1997; Kuemmerle, 1999a). Kuemmerle (1999a) showed that there are distinct waves of FDI in R&D by country of origin. US companies were pioneer investors in R&D facilities abroad and invested first in Europe, then in Japan, then in the rest of the world (primarily Canada, Australia and a small number of Asian countries). European companies invested first in other European countries, then in the US and then in Japan but only to a very limited degree in the rest of the world. The surge of Japanese investment to the US, Europe and the rest of the world started simultaneously in the early 1980s but rose strongly only in the late 1980s and 1990s, but did so simultaneously in the US, Europe and in the rest of the world. The study also found that the US was the most attractive location for FDI in R&D, attracting 30% of all R&D sites established abroad.

A considerable part of the existing literature on FDI argues that FDI occurs when firms seek to exploit firm-specific capabilities in foreign environments (Dunning, 1995; Hakanson, 1990; Hymer, 1976; Vernon, 1966) and suggest that a high level of local R&D is carried out primarily to adapt products to local markets (Hakanson and Nobel, 1993; Howells, 1990a). Traditionally, most FDI into manufacturing and marketing units have fallen into this category. In the case of R&D, these are often called *asset exploiting* R&D (Dunning and Narula, 1995) or *home-base-exploiting* R&D (HBE R&D) (Kuemmerle, 1999b). Home-base exploiting R&D is mainly concerned with adapting home base R&D to local requirements and is likely to be closely connected to and located in proximity of foreign manufacturing and marketing. Several researchers have described the importance of FDI in R&D for exploiting firm-specific capabilities in foreign environments (Bartlett and Ghoshal, 1990; Hakanson, 1990; Vernon, 1966). They argue that as local demand grows increasingly sophisticated, local R&D facilities are useful in helping a firm to adapt existing products better to local needs. As firms establish manufacturing facilities abroad and assign increasingly complex products to them, locating R&D sites in close proximity to factories becomes a requisite feature. These sites support the transfer of knowledge and prototypes from the firm's home location to actual manufacturing. The importance of co-locating some firm R&D efforts with manufacturing operations and local demand has been described not only in the international business literature, but also in industrial geography (Howells, 1990) and technology management literature (Clark and Fujimoto, 1991; Hayes and Wheelwright, 1988; Nonaka and Takeuchi, 1995; von Hippel, 1988).

In contrast to the capability-exploiting motive for FDI in R&D, a number of researchers have pointed out that particularly in the case of R&D, the main driver for FDI might be a firm's need to augment its knowledge base (Cantwell, 1991; Dunning 1998; Florida, 1997; Howells, 1990). These are often called *asset augmenting* R&D (Dunning and Narula, 1995) or *home-base augmenting* R&D (HBE R&D) (Kuemmerle, 1999b). Home-base augmenting R&D requires developing links with host-country R&D systems to enhance the knowledge base at home and to more closely connect to the foreign R&D environment and gain access to local knowledge (Florida, 1997). Wesson (1993) has made a similar argument for FDI in general. These researchers argue that specific nations and specific regions within them might be particularly advantageous locations for R&D facilities because of potential knowledge spillovers from existing and productive R&D organizations. Such organizations include research universities, publicly funded research institutes and innovative competitors. Feinberg and Gupta (2004) advanced the argument that potential knowledge spillover opportunities are highly relevant for the choice of offshore location. Accordingly, the gains obtained from knowledge activities (R&D and product development and design) are becoming increasingly important (Dunning, 2000). Other externalities that make a country attractive for FDI in R&D involve the availability of supporting industries offering inputs, such as firms that provide laboratory equipment, maintenance or specialized laboratory testing services. A direct extension of these dynamics is the emergence and evolution of global R&D networks which are separate and distinct from R&D FDI or Greenfield R&D investments (see Murtha, 2004)

The rapid advances in IT and ICT have greatly enabled the dis-intermediation and externalization of innovation processes through outsourcing and remote relocation of R&D groups and laboratories overseas (Howells, 1990 and 1995). Moreover, companies seem to increasingly choose offshore locations independent of geographical distance and have located their ITO, BPO and other functions and processes in less developed, lower cost countries. The particular case of the more recent wave of offshoring innovation should therefore be understood as part of the broader phenomenon of internationalization of R&D (Murtha, 2004). Recalling our earlier definition of offshoring, it appears that offshoring strategies are evolving from *home-base augmenting* (HBA) to what we can define as *home-base replacing* (HBR) innovation capabilities. This seems to be the case for larger MNEs, whose strategies have been extensively discussed in the IB literature, whereas smaller and medium sized companies (SMEs) may be adopting innovation offshoring strategies that augment their limited innovation capabilities (HBA

In order to explain why firms choose this new form of organizing the innovation process, we rely on the literature on innovation and change, which suggests that environmental forces and managerial practices co-evolve in influencing the adoption of innovation, new organizational forms and new practices by firms (Lewin and Volberda, 1999, Lewin et al., 1999 and Volberda and Lewin, 2003). Along the same lines, it has been argued that internationalization paths and processes should be viewed as the joint outcome of management intentionality, experience-based learning, and institutional forces (Flier et al., 2003; Hutzschenreuter et al., 2007). Following this stream of research, we argue that the adoption of innovation offshoring by firms is the result of three types of factors: environmental factors, managerial intentionality, and path dependence and learning.

The environment

Reflecting on and testing all the environmental variables possibly having an influence on firms' innovation offshoring decisions is beyond the scope of this paper. In that respect, Manning et al. (2008) provide a comprehensive perspective on the many coevolving forces that have shaped the evolution of offshoring and related globalization of innovation. Kshetri (2007) also shows how institutional factors such as regulations, rules and habits influence offshoring decisions.

In this paper, we focus on the idea of a growing shortage of technical and scientific talent that would constraint firms' possibilities to rely exclusively on the supply of scientists and engineers available in the US. Policy debates over the growing shortage of workers with scientific degrees have been increasing in frequency and intensity in the US, and in other countries (Cohen and Zaidi, 2002), reflecting the fact that the shift to a knowledge-based economy results in an increased importance, as well as scarcity, of knowledge workers. Freeman (2005) provides data suggesting that job market for scientists and engineers (S&E) graduates in the US has worsened compared to that of other high level occupations such as Law or Medicine. As a result, fewer Americans are attracted to these fields of studies. But the author also highlights that S&E job market conditions remain sufficiently good to attract highly qualified immigrants. Moreover, an increasing percentage of S&E PhDs are earned by foreign-born students (39% in 2000 compared to 6% in 1966). This fact by itself would not be a cause for alarm if these foreign students trained in the US were staying in the US. But it seems that increasingly they take advantage of the growing work opportunities in their home countries (Lieberthal and Lieberthal, 2003; Chanda and Sreenivasan, 2005; Zweig, 2005). Freeman (2005) further notes that an increasing percentage of PhDs are being hired by companies, where they quickly move into management positions, as opposed to taking post-docs positions.

As illustrated in Figure 1, the number of US nationals earning Master and PhD degrees from US Science and Engineering Schools has been declining steadily starting in 1995. Conversely, the number of foreign workers on H1B visa, the majority of whom work in science and engineering fields, increased steadily between 1998 and 2003. But in 2003, the US Congress did not renew the H1B visa quota at the 2002 level and the quota lapsed to the pre 1998 level. Since then, the quota has remained constant at 65,000. The combined result of these two forces is that in 2006, the number of S&E workers available to work in the US is below the 1995 level. At the same time, US GDP has increased between 1995 and 2006 by 43%, suggesting a growing demand for, and a possible shortage of S&E workers. Economic theory would suggest that wages will adjust so that market conditions will improve and the shortage will be avoided. However, because the S&E job market has morphed to become global, the adjustment, if any, is likely to require much more time than it used to when labor markets were still very much nationally bound. The fact that companies are able to offshore even technically-advanced activities allows them to access S&E workers globally to support their business, which reduces the pressure on wages in the US and may therefore delay the possible market adjustment. This might be a reason why traditional economic indicators such as wages and unemployment do not seem to confirm the perceived shortage of S&E (Butz *et al*., 2003). This is also in line with Farrell *et al*. (2006) findings that, although growing, offshoring will not trigger sudden discontinuities in wages and employment in developed nations.

Consistent with Oliver (1991) we assume that companies strategically react to consequences of misalignments between their strategic needs and the configuration of the institutional structure and the macro environment in which they are embedded. In the present case, the cause of the misalignment is the decline in number of US nationals (and permanent residents) with advanced degrees in science and engineering combined with H1B visa quota cut back. Firms can be expected to escape the institutional constraints of their country (Witt and Lewin 2007) and respond to emerging talent shortage by accessing talent offshore and globalizing their innovation activities. But following Oliver (1991) we do not expect that all firms perceive the shortage of talent at the same time or adjust to it in the same way (Nelson, 1991). Some companies may resign themselves to the situation, hire less qualified workers or voice (Hirschman, 1970) their concerns and demand political resolution through their industry associations or lobbying networks, which indeed did enact the annual H1B quota for highly skilled talent to work in the US. However, agreeing to and implementing structural changes in the configuration of national institutional structures that would increase the attractiveness of careers in science and engineering (e.g. reforming the teaching of mathematics and science in the K-12 educational system) or attract scientist and engineers to work in the US are very complex issues to resolve and very bureaucratic to implement and therefore require much time[2].

At the same time as the attractiveness of S&E careers diminishes in the United-States, the talent pool of several offshore countries has been increasing. Ernst (2006) finds that the success of Asia in attracting innovation offshoring largely results from major investments in improving and expanding the talent pool available. For instance, first year doctoral students in S&E in China increased six-fold between 1995 and 2003 (Freeman, 2005). In parallel, the Chinese government has launched programs targeted at retaining university graduates in China as well as attracting talent from abroad, Chinese or not (National Science Board, 2004). In fact, instead of an absolute shortage of S&E, which would probably appear in wage and employment statistics more than it currently does, the US may be facing a relative shortage of technical skills compared to worldwide supply. In other words, even though companies may be able to find in the US the S&E talent that they require for their current needs, unless other constraints such as IP issues deter them from doing so, they might prefer investing in countries where the relative pool of talent is larger and because of the opportunity to grow their S&E workforce as their business expands in the future. Another consideration for some companies is the realization that the countries with a large potential supply of S&E professionals also represent fast growing markets that many US firms seek to enter. Learning to source and manage S&E activities in these countries might constitute a

[2] For a report on policy proposals intended to increase the supply of engineers and scientists in the U.S. and a discussion of the consequences of a continued shortage of engineering and science talent in the U.S. see "Rising Above the gathering Storm: Energizing and employing America for a Brighter Economic Future" Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology, National Academy of Sciences, National Academy of Engineering, Institute of Medicine, ISBN: 0-309-65463-7, 504 pages (2005).

longer term advantage as companies utilize their new local NPD capabilities to start developing products adapted to the needs of these local markets..

Managerial intentionality

Hutzschenreuter *et al*. (2007) present managerial intentionality (MI) as a key factor underlying firms' heterogeneity in many areas such as internationalization paths, innovation or performance. According to the authors, MI would encompass firms' growth strategies to become global, orientation towards innovative or mimetic internationalization, management of the adaptive tension, use of slack resources, attitude towards employee creativity and initiative taking, and so on.

The idea behind the concept of managerial intentionality is that managers have certain strategic objectives in mind that they translate into certain decisions, which influence firm-level outcome. In the area of offshoring, many different strategic objectives have been recognized to play a role. Dominant conventional wisdom has been that the primary driver for offshoring IT centers, IT applications and business processes is to realize cost savings from labor arbitrage (see e.g. Quélin and Duhamel, 2003; Dossani and Kenney, 2004; Khan and Islam, 2006). However, Lewin and Peeters (2006a and b) report a notable evolution in the strategic drivers with the emergence of company growth, access to qualified personnel or service improvement as increasingly important objectives leading firms to initiate offshoring projects. Several studies also show that the importance of cost savings as a driver of offshoring tends to decline as companies gain experience with offshoring and experiment with offshoring of increasingly complex and advanced activities. For instance, Pedersen and Orberg Jensen (2007) show that cost factors determine the initial decision to offshore but not subsequent evolution towards offshoring of more advanced activities, confirming earlier findings by Maskell *et al*. (2007) that companies evolve from cost reductions to knowledge seeking objectives. Along the same lines, Dossani and Kenney (2003) illustrate the change in companies' mindset from cost to quality.

Recent work by Bunyaratavej et al. (2007) has also demonstrated that cost is not as important as what the mass media might suggest, but that access to skilled and qualifies personnel is a substantial driver of services offshoring among firms. Namely, they argue and find support for the notion that firms seek to obtain parity in terms of the quality of the onshore workforce, but at some level of discounted wages. However, since Bunyaratavej et al. (2007) studied actual offshoring activities and not managerial intentions, the model developed in this paper, which involves managerial perceptions regarding access to qualified personnel, provides new insight to the literature and toward closing the loop that is currently open regarding possible divergences between managerial intentions and firm-level actions.

In this paper we investigate four main types of firm specific objectives, as expressions of managers' intentionality, that may determine decisions to offshore innovation (besides cost savings): access to qualified personnel, accelerating growth, importance of increasing speed to market, and becoming global players. Ernst (2006) argues that competing in the emerging global market for knowledge workers has become a strategic priority for firms, high-tech in particular, as it creates new sources of talent that they have no choice but to tap in order to optimize their human capital. Combined with the evidence on tight labor market for S&E graduates in the US, this suggests that a firm's need for finding qualified personnel is likely to be an important determinant of its decision to offshore product development work. Similarly, as a means to increasing the pool of resources (talent) available to a firm, offshoring can alleviate some constraints that are potentially hindering the firm's growth objectives. The growth strategy of a firm may involve expansion of existing businesses and entering new markets. For science and technology based companies in particular, exploiting new market opportunities often requires access to engineers and scientists capable of developing new products and technologies or adapting exiting ones. Companies with significant growth objectives may therefore decide to offshore portions of their product development activities to countries where such talent are in relative abundant supply. The pressure to increase speed to market with new or improved products faster than competition may also affect companies' offshoring strategies. Speed to market can be improved by having access to a flexible pool of qualified engineers necessary for responding to changes in demand and for exploiting market and technological opportunities, as well as by new organizational arrangements that enable development around the clock (most product development teams typically work dayshift in the US). Deploying teams of qualified engineers offshore has been shown to provide flexibility to scale product development efforts up or down as needed, and allow companies to manage product development processes using a follow the sun schedule. Finally, internationalizing innovation through offshoring leads firms to further globalize their activities as they tap new geographic knowledge clusters (diverse labor pools, specific expertise anywhere in the world).

Path dependence

It is unlikely that offshoring decisions will exactly reflect managers' vision of what to offshore or not at any moment in time. Offshoring decisions are also constrained by the offshoring journey a firm has followed in the past, and influenced by past learning on how to manage offshoring projects. In other words, whether a firm does have some past experience with offshoring or not, and the kind of functions or processes previously offshored, will serve to further enable or constrain future offshoring decisions.

The path dependence of offshoring practices has already been recognized by several authors. For instance, Lewin and Peeters (2006), Maskell *et al*. (2007) and Pedersen and Orberg Jensen (2007) describe the adoption of offshoring by firms as a progressive learning by doing process through which firms offshore increasingly advanced activities, including innovation activities. This experience building process that leads firms to eventually offshore innovation confirms earlier research by Pisano (1990) who argued that R&D procurement decisions are driven in part by historical factors. Three main reasons can explain the role of companies' past experience in determining their offshoring decisions. First, the behavioral and evolutionary perspectives of firms' practices suggest that, because of the search rules (Cyert and March, 1963) and routines (Nelson and Winter, 1982, Nelson, 1991) normally used by firms, a history of internal R&D sourcing is likely to lead to the continuation of internal R&D sourcing even if the environment changes incrementally. Second, several authors have used transaction costs theory to explain firms' sourcing decisions (e.g., Calantone and Stanko, 2007; Murtha 2004; Murray and Kotabe 1999; and Pisano 1990). The argument is that firms with no experience of R&D outsourcing are likely to continue sourcing R&D internally because experience with internal sourcing reduces the cost of performing the R&D activities internally (Coase, 1937). Similarly, it may be risky for these firms to start experimenting with a new form of R&D sourcing. The same reasoning may be applied to offshoring decisions. Finally, firms' past experience may also influence the range of possibilities managers consider when making offshoring decisions (Hutzschenreuter et al., 2007).

3. Methodology

The Offshoring Research Network

This research uses data collected in the context of the Offshoring Research Network (ORN) project on offshoring of technical and administrative work. ORN was launched in 2004 at Duke University Center for International Business Education and Research (CIBER), Fuqua School of Business[3]. In 2004 and 2005 ORN focused on surveying the offshoring practices of US based companies. In 2006, the online survey was extended to involve research partners from EU universities[4] who recruit companies to participate in the survey as well as conduct case studies. At the core of the ORN project is the contextual commonality of the survey, the centralized online administration of the survey (in native business language of a country where necessary) each year. The core survey enables tracking the evolution of offshoring practices involving seven main areas: the functions offshored, choice of offshore location and rationale for this choice, type of service delivery model used (captive, third party, hybrid), strategic drivers of offshoring, perceived risks, performance metrics, and future offshoring plans (18-36 months out).

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[3] As of 2006 the ORN lead corporate sponsor is Booz Allen Hamilton the global management consulting firm. The 2004 and 2005 surveys were supported by the Duke CIBER and Archstone Consulting LLC. In 2007 The Conference Board and PriceWaterhouseCooper became lead collaborators of the ORN Project.

[4] Partner Universities include Copenhagen Business School (covering Scandinavia countries), Wissenschaftliche Hochschule fur Unternehmensfuhrung (Germany), RSM Erasmus University (Netherlands), IESE (Spain), Manchester Business School (UK), and Solvay Business School (Belgium).

A unique feature of the ORN survey is its focus on surveying the specific offshore project implementations and not on companies' general experience with offshoring. In practice it means that every specific function that a company (sometimes involving multiple respondents from same company) has offshored in a particular location is identified by the year it was launched and is treated as a separate observation. This survey design results in a very fine-grained database that enables an analysis of offshoring dynamics across various administrative and technical functions located in a wide range of countries or regions of the world, across industries and across types of delivery model (captive, third party or hybrid). Finally, the ORN database includes both companies that do already offshore as well as companies that consider offshoring but have not yet initiated the offshoring of any application.

Data

The present paper uses data from the 2005 and 2006 ORN annual surveys of US companies. The database comprises 253 companies and 880 different offshore implementations, most already operating and some in preparation at the time of the survey. Launch dates of offshore implementations range from 1990 to 2006, and are available for 476 implementations. The sample comprises both large and small companies operating in various industries (see Table 1). Median company employment is 1,750 employees and the average company employment is 22,691 employees.

Insert Table 1 about here

The analysis of the ORN survey classifies offshore implementations into five main functional categories (see Table 2): Administrative (finance and accounting, human resources, legal services, marketing and sales, and other back office activities), Contact Centers (call centers, help desks, and technical support), IT (Information Technology related activities), Procurement, and Product Development (R&D, engineering services and product development and design, including software design). IT applications were among the earliest ones to be offshored and account for the highest share of implementations in the sample (26%). This may also be a direct consequence of the good service and quality reputation of India, which continues to be the most preferred offshore location (specifically as regards IT, see Henley, 2006). More surprising is the finding that 26% of offshore implementations involve product development activities. This suggests that companies are offshoring innovative activities that constitute the core of a firm differentiation and value creation strategy, that are expected to remain under direct control. Administrative activities also represent a large share of surveyed implementations (22%). Despite the large coverage in the press and popular media, contact centers represent only 17% of offshore implementations.

Insert Table 2 and Figure 2 about here

ORN data show that “access to qualified personnel” has emerged as the second most important strategic driver of offshoring. On a five point Likert scale it is rated important or very important (4 and 5) for 77% of offshore implementations surveyed. Similarly, the survey reveals that availability of sufficient talent pools and adequate expertise have also emerged as very important reasons for why US firms select particular offshore locations. The particular strategic objectives underlying offshoring decisions vary depending on the type of function offshored (see Table 3). The access to qualified personnel objective is the second most important for both product development and non product development offshore implementations. But the percentage of implementations for which this objective is rated important or very important is higher for innovation-related offshoring. In fact, this pattern of similar ranking but higher relative importance for product development implementations applies to the other major strategic drivers of offshoring as well: non-labor cost savings, growth, global strategy, competitive pressures and speed to market.

Insert Table 3 about here

Finally, industries differ in their proportion of product development offshoring, as well as offshore countries differ in their ability to attract this type of offshoring (Table 4). In the Software and Programming industry, almost 50% offshore implementations concern product development. In Business and IT services, Health/Biotech/Pharma, Manufacturing, and Technology industries about one third of offshore implementations are in product development. The very high percentage for the Professional Services industry should not be extrapolated too much given the very low number of observations. Finally, Financial Services and Other Services, although actively involved in offshoring, have only few implementations related to product development.

Insert Tables 4 about here

Regarding offshore locations, the proportion of product development implementations out of total offshore implementations is the highest for China (44%). Other Asian countries also attract proportionately more innovation offshoring than other locations. Weakest regions in terms of product development offshoring are the Philippines, Mexico, Canada and Latin America. Contrarily to China, Mexico does not seem to have been able yet to upgrade its capabilities to move from manufacturing production offshoring to higher value activities in product development.

Empirical validation

The objective of this paper is to empirically test possible determinants of firms' decision to offshore product development work. In order to do this, we built a model that estimates the probability of offshoring product development projects in function of a series of variables related to the firms' environment, past experience, and managers' strategic objectives, and a set of control variables that account for differences in firms' size and industry, and in location and service delivery model of offshore implementations. The equation is estimated as a binary logit model where the dependent variable reflects the type of function offshored, whether product development (R&D, engineering services, or product design) or not.[5]

The environment in which firms operate may influence their offshoring decisions in many ways. In this paper we study the effect on the decision to offshore innovative work and services of the supply of technical talent in the US, through both US Science and

[5] Table 5 provides a detailed explanation of the construction of the variables.

Engineering graduates and foreign workers on H1B visas. In order to take into account of a possible growing shortage of technical talent leading to increasing product development offshoring, we introduce in the equation the number of S&E Master and PhD degrees and the level of the H1B visa quota on the year the offshore implementation was initiated, in logarithm (lnSEH1B). Data on graduates and visa quota come from the US National Science Foundation and the US Citizenship and Immigration Services respectively. We expect the supply of technical talent variable to have negative impact on product development offshoring decisions, i.e. the larger the pool of technical talent available in the US the lower the probability of offshoring product development.

To test for the effect of managerial intentionality as determinant of firms' probability to offshore product development, we use the ORN survey responses related to the strategic drivers that led companies to initiate their various offshore projects[6]. We selected seven strategic drivers on the basis of their importance, of the differences between PD and non-PD implementations (see Table 3, which also reports the Chi-2 test and probability that the proportion of 4 and 5 answers for PD and non-PD are significantly different) and of previous research reported in extant literature. They are the access to qualified personnel offshore (QUAL_PERS), realization of labor cost savings (COST_LABOR), realization of other types of cost savings (COST_OTHER), contribution to firms' business growth plans (GROWTH), contribution to firms' global strategy (GLOBAL), acceleration of speed to market (SPEED), and response to competitive pressures (COMPETITION). We expect all strategic drivers to have a positive impact on the probability to offshore product development work, except for labor cost savings and competitive pressure, which involve short term strategies as compared with longer term innovation strategies offshore.

[6] The survey question was: "For each function, please evaluate the importance of the following strategic drivers in your decision to offshore", to be evaluated on a 1 to 5 likert scale ranging from not important at all to very important.

The learning process of offshoring may involve how to overcome crucial coordination and knowledge flow challenges central to innovative activities. Firms that have already offshored product development activities may have developed managerial and coordination competences which may increase the probability of deciding to offshore new projects related to their innovation processes. We therefore expect the probability of offshoring product development to depend on how many product development projects the company has already offshored in the past (PAST_EXP_PD).

Another important aspect of offshoring strategies is the delivery model selected for undertaking activities outside the domestic boundaries. The mode of entry in an international market has been extensively discussed in the literature (e.g., Dunning, 1993). A firm basically has three choices when investing in R&D abroad: establishment of a green-field site, an acquisition, or a joint venture (Kuemmerle, 1999a). Caves (1996) argues that multinational enterprises will refrain from FDI through joint ventures when the protection of intangible assets is important to the firm. Mansfield (1984) found that firms are more hesitant to transfer process technology abroad than product technology because it is more difficult to protect process technology from appropriation by local entities and because process technology often manifests unique firm capabilities while product technology just represents the outcome of these capabilities. On the other hand, acquisitions or captive facilities bring high risk of attrition of assets, like human assets which are highly mobile.

The ORN survey includes questions about alternative models: captive, outsourced to various service providers (local, same nationality, international) or joint venture. Quinn (2000) argues that tapping the knowledge and capabilities of external organizations has become crucial for firms to stay ahead of the innovation race, leading them to outsource more and more elements of their innovation value chain. The externalization of product development is now increasingly being extended to offshore destinations. However, the ORN survey reveals that, due to concerns about a possible loss of control over strategically important activities, a majority of companies offshoring product development activities favor offshoring through a fully owned subsidiary, what is also referred to as the captive model of offshoring, over the offshore outsourcing model. But not all firms do have the resources and scale to launch a captive organization offshore, which may have an influence on their decision to offshore product development or not. To control for this possible effect we introduce in the model a dummy variable that takes the value of 1 if the offshore implementation is a captive organization, and 0 otherwise (Captive).

In the model we also control for the firm size and industry, and for the region where the offshore implementation is located. The size of the firm and the industry in which it operates may influence the relevance of pursuing a product development offshoring strategy, as well as the feasibility of such a strategy given the organizational challenges associated with operating geographically dispersed innovation teams. To account for these possible effects we introduce the logarithm of the number of employees (lnEmpl) and seven industry dummies ($Industry_p$) as control variables in the regressions. Moreover, some countries are more likely than others to attract innovation offshoring projects. As discussed above, innovation offshoring is facilitated by offshore countries heavily investing in the development of pools of qualified workers. But, for various reasons, offshore countries are not equally capable of developing such talent pools. ORN survey data do reveal important differences in the proportion of product development projects across countries (see Table 5), which will be controlled for in the regressions using nine country dummies ($Country_q$). The last control variable accounts for the possible change in companies' behavior with respect to offshoring starting 2003, which would not be captured by the other variables of our model. The change in sourcing strategy for product development starting in 2004 compared to earlier years might be due to firms having to adjust to both the new H1B visa regulation and the return to economic growth after two years of economic recession that followed 9/11.

The estimated equation is shown below. In the estimated equation, the constant intercept is *a* and ε is the error term:

Prob(PD) = *a*+ *b* lnSEH1B + *c* PAST_EXP_PD + *d* QUAL_PERS + *e* COST_LABOR + *f* COST_OTHER+ *g* SPEED+ *h* GROWTH + *i* GLOBAL + *j* COMPETITION + *k* lnEmpl + *l* Captive + *m* D2003 + $\sum_{p=1\to 7} n_p\ Industry_p$ + $\sum_{q=1\to 9} o_q\ Country_q$ + ε (Equation 1)

Descriptive statistics and correlations between the explanatory variables are reported in Tables 5 and 6.[7]

4. Results

Hierarchical estimation results for Equation 1 are reported in Table 7. The first column shows estimated coefficients for only the control variables (Col. 1), followed by control variables and the domestic supply of S&E (Col. 2), control variables and past experience (Col. 3), control variables and strategic drivers (Col. 4), and control variables and all explanatory variables (Col. 5).

Insert Table 5 about here

The negative effect of firm size throughout the various models indicates that smaller firms have higher probability of offshoring PD projects, indicating that offshoring enables smaller and more agile companies to augment their innovation capabilities (HBA) in contrast to larger more resourceful companies who are also using Offshoring strategies to replace innovation capabilities (HBR). The dummy for captive model of offshoring is positive and strongly significant. This result supports the argument that innovative activities require a higher degree of coordination and stronger governance structure that

[7] Three correlation coefficients, between Speed and Global, Overall supply of S&E and D2003, and between Cost of labor and Other costs present medium values (respectively 0.43, -0.43 and 0.38) and statistically significant at 1%. However, when we entered the two variables involved separately the regression results differed only marginally indicating these correlations do not affect the regression model.

facilitates knowledge flow and integration and reduces the risk of IP leakage, all of which is made easier in fully owned subsidiaries compared to outsourcing. Sectoral dummies indicate that, compared to Financial services, all the other sectors have a higher probability of offshoring PD, with the exception of Other Services. In terms of destinations, there is some evidence that compared to Latin America; PD projects are more likely to go to China and other Asian regions, but less to the Philippines.

The domestic supply of scientists and engineers, US citizens with post graduates degrees and foreign workers with H1B visas, has a negative impact on the probability of offshoring PD (Col. 2), supporting our conjecture that the lack of talent and skills in the US is one reason why R&D, engineering services and product design activities are increasingly offshored. Consistent with the importance of cumulative learning and idiosyncratic knowledge developed in implementing and managing and coordinating product development activities offshore, past experience in offshoring product development increases the probability that companies further offshore PD (Col. 3). Among the strategic drivers of offshoring, access to qualified personnel, increase speed to market and reducing other costs (non labor costs) have a positive impact on the probability of offshoring PD, whereas concerns about labor cost savings and offshoring for growth objectives reduce the probability of offshoring PD. Finally, offshoring as part of a global strategy and responding to competitive pressure present the expected sign but not very high probability of impacting the probability of offshoring PD (Col. 4).

The negative and significant coefficient of the labor cost savings and the positive and significant coefficient of other cost savings clarifies the role of labor arbitrage opportunities in explaining offshoring of technical and administrative work and global search for talent. The analyses indicate that offshoring may be a strategy for increasing cost efficiency also for PD activities, but not through labor arbitrage. Labor costs savings and the need to offshore in order to access qualified personnel are two different strategies that companies do not confound. Cost savings opportunities are certainly an important driver for many offshore implementations, but when firms need to support their innovation centered strategies in the face of scarce talent, labor cost considerations are less important relative to accessing talent anywhere.

The significant negative coefficient of the growth strategy variable indicates that, although some companies, smaller ones in particular, offshore product development work to support their expansion plans, offshoring of innovation activities is a separate strategy from growth. Innovative processes and activities normally have longer term time horizons whereas growth is more likely to have shorter time horizons. Therefore, if companies are focusing on shorter term growth objectives it is less likely that they will attend to offshoring PD activities.

When all the above variables are included in one model (Col. 5), supply of domestic talent and past experience lose their significance, whereas all the other variables, strategic drivers and controls, remain similar to the previous model. This result may indicate that managerial intentionality has stronger importance than supply of technical talent or past experience in explaining firms' decision to offshore PD.

The diagnostics at the bottom of table 7 indicate that overall the models are meaningful (LR Chi2), that the model with the strategic drivers variables (Col. 4) and the full model (Col. 5) have higher pseudo R2 than previous models, and that the full model has the highest log likelihood.

In order to interpret the results better and discuss the magnitude of the estimated effects, the odds ratios have been computed and are reported in Table 8. Since only significant ratios can be interpreted, for the full model (Col. 5) they should be interpreted as the increase/reduction in likelihood of offshoring PD over other functions when the importance of a particular strategic driver increases by 1 point on the 5 points scale. We therefore expect stronger labor cost savings objectives to result in a 38% reduction in the probability of offshoring PD over other types of functions. But efficiency improvements do play a significant role in explaining offshoring of PD since strong non-labor cost savings objectives are associated with a massive increase in the probability of offshoring PD. Similarly, when accessing qualified personnel or speed objectives rise in importance by 1 point, this probability increases by 67% and 73% respectively. Finally, as growth objectives become more predominant, the likelihood of offshoring PD over other functions diminishes by 36%.

The 2003 change in H1B visa policy and return to economic growth after two years of stagnation have modified the environment within which US firms operate. To further investigate the possible effect of this modification on the reasons that lead firms to offshore PD, we divided the sample into two subsamples and estimated the equation for implementations launched between 1990 and 2002 and for implementations launched between 2003 and 2006 separately[8]. The results are reported in Table 9. Due to the limited size of the two subsamples, the number of industry and country dummies was reduced to control for differences between the two most important locations of offshore implementations (China and India) and other possible offshore regions, and for differences between technological and non-technological industries. With regard to the central question of this paper, that is the effect of accessing qualified personnel, a striking difference between the two subsamples emerges. Although this strategic objective was not an important driver of firms' decision to offshore PD up to 2002, it became a highly positive and significant determinant of PD offshore implementations initiated from 2003. Offshoring as part of companies' larger strategies to become global is another determinant of PD offshoring decisions that became significant only starting in 2003. The effect of companies' past experience, although only marginally significant, seems to be gaining in importance in the last years covered in the study as well. Conversely, the negative effect of labor cost savings loses significance in the second subperiod, suggesting that more recent PD offshore implementations do consider labor arbitrage opportunities more than older PD implementations. Finally, two changes in the significance of control variables should be acknowledged. First, although China used to have a bias towards PD offshore projects, probably because of the need to be located close to existing manufacturing plans (Kenney and Florida, 1994), as HBE offshoring

[8] We tested the models also for pre 2003 and post 2004 subsample, and obtained very similar results. Results are available from the authors.

strategy, China's profile in terms of type of offshoring it attracts seems to be converging to that of other regions. This can be either due to China's efforts to diversify its economy, or to other regions improving their technical skills. Second, PD offshoring in the post 2002 period seems to be expanding to non technological industries as well.

5. Discussion: The global race for talent and offshoring innovation

Consistent with internationalization research, firm strategy to search for and access talent globally can be seen as another manifestation of firms internationalizing their operations by seeking assets or capabilities outside of their national boundaries (Wesson 1993, Caves 1998). Offshoring is a variant of foreign direct investment (FDI), or international joint ventures, or partnerships to build firm specific, location specific or internalization advantages (Dunning 1980). Dunning (1993) has identified market-seeking, resource-seeking, efficiency-seeking, and strategic asset-seeking, as motives for developing foreign operations. Within this framing seeking and accessing talent globally is not a novel strategy. It is another example for seeking resources (i.e., knowledge seeking), perhaps driven by efficiency seeking (i.e., cost reduction).

In this paper we argue that talent is a different type of asset and that the search for talent globally is emerging as a new phenomenon. Companies are not just diversifying their sources for talent, but are entering an era where they must compete for talent (see the Economist special report October 5, 2006). Consistent with the resource based view of the firm, unobservable and inimitable organizational knowledge and processes are sources of firm competitive advantage and account for much of the variation in firm performance (Wernefeldt, 1984; Barney 1991). Talent is to a great extent an intangible resource that is embodied in individuals, groups and social networks. Talent is an integral element of the knowledge base of the firm and consists of a wide range of highly specialized technical skills and knowledge (e.g. process knowledge). The realization that an absence of a specific skill or talent is critical for proceeding with a project often only becomes evident during the process of undertaking specific projects, especially in the case of product innovation. In comparison to typical physical assets, talent is characterized by a different kind of obsolescence (e.g. embedded in geographic knowledge clusters or networks). It is also highly mobile and must be renewed on an ongoing basis by managing variation and through appropriate HR strategies such as training and retraining.

Furthermore, the dynamics of the supply of engineering and science talent are changing. In addition to the effect of the ageing of the population, for reasons that are not well understood, fewer young people in western economies are selecting advanced degrees for entering careers in science and engineering. It is beyond the scope of this paper to review the many factors that affect this change in preferences except to note that this trend affects all the industrialized countries (US, EU, and Japan). At the same time, Asian countries such as India and China and certain countries in Eastern Europe and in Latin America are becoming recognized as pools of highly qualified engineering and science talent. If companies are realizing, as the Economist Special Report (October 2006) argues, that they are facing a race for talent because of a growing shortage of talent, then the phenomenon under investigation is about companies competing for talent globally and not about seeking engineering and science resources in low cost countries (e.g. Belderbos and Heijltjes, 2005; Khanna and Palepu, 2004).

The rise in the frequency of companies that cite accessing global pools of qualified personnel and expertise as strategic drivers for offshoring product development applications and for selecting certain country locations may be indicative of companies recognizing the growing shortage of technical talent in the US. In this context, the introduction of the H1B visa quota can be understood as a response by policy makers to the lobbying by companies for relief from the growing engineering and science talent shortage. The empirical analyses presented in this paper supports our argument that the shortage of technical talent in the US, which became starkly apparent to companies when, in 2003, the H1B visa quota was drastically decreased, impacted the ability of many companies to execute their growth opportunities that were dependent on product development capabilities. In order to adapt to this significant change in their environment, companies entered a global search for talent that led them to offshore product development activities to countries and cities where they could find sufficient pools of qualified personnel and expertise. In the 1990s very few companies seem to have recognized the role of offshoring in addressing problems of sourcing the requisite talent for expanding their business. It is not surprising that companies have to gain some experience with the new practice of offshoring before fully understanding the strategic value it can deliver, beyond labor arbitrage.

Our conclusion is consistent with recent work on the growth of offshoring innovation by Ernst (2006) and Thursby and Thursby (2006), who argue that the US should remove obstacles to immigration of highly skilled workers and to enlarge the pool of knowledge workers by providing incentives to study in science and engineering. The relation between constraints on accessing talent and innovation sourcing decisions had already been recognized by Quinn (2000) who recommends outsourcing innovation to attract talent because companies may have difficulties attracting the most qualified people for their non-core activities. These workers are likely to prefer working for specialist companies where their expertise will be best recognized, used and rewarded. Today, a similar argument can be made about the offshoring of innovation, as Ernst (2006) notes when he concludes that companies offshore exciting R&D projects to "attract the best and brightest of the local talent pool", instead of falling back on "second-choice" workers at home. Interestingly, Florida (1997) finds that R&D FDIs into the US are also driven by the desire of firms to access scientific and technical human capital. To a certain extent, what used to be true for the US in the 90s seems now to apply to emerging countries as well.

Although improving the efficiency of innovation processes is a major objective of firms offshoring PD, the results from our models support our argument that accessing global talent pools and reducing labor costs are two separate and different strategies driving offshoring decisions by companies. Accessing talent is linked to companies involved in product development centered innovation, while labor cost savings are associated with companies seeking to replace high cost workers (mostly lower skilled) with lower cost workers. Cost savings form labor arbitrage is certainly important contingencies driving the growth in adoption of offshoring practices that the ORN study documents.

Nevertheless, the pattern of offshoring activities by American companies that emerge from the ORN study does not fit the traditional story of companies simply trading non core low level workers in the US with low cost labor offshore. First, offshoring concerns increasingly core and technical activities performed by highly-trained workers (university graduates from science and engineering schools in particular). Second, on the basis of ORN data, less than one out of ten offshore implementations of technical activities has resulted in job losses in the US. Offshoring of product and process centered innovations have enabled companies, large and small, to increase the level of resources dedicated to their innovation efforts, without laying off their domestic engineering and R&D staffs. In other words, in the face of a global race for talent, when it comes to offshoring product development work necessary for a firm to maintain its technical leadership and increase its speed to market, labor cost is not the key variable. Many other elements are likely to come into play and this paper shows that access to talent is definitely a key element.

The results reported in this paper have to be placed in the context of the broader phenomenon of increased globalization of human capital (Friedman, 2005; Florida, 2005) and emerging global talent pool (Levin Institute, 2005). In the industrial economy, workers used to migrate from less developed regions towards more industrialized regions to seek jobs. In the knowledge IT-enabled economy, entire segments of companies' value chains are relocated to where the requisite human capital is located as a necessary condition for executing certain business functions and processes. In one sense, offshoring is nothing more than the mechanism through which companies achieve such reorganizations.

Conclusions

The empirical study reported in this paper brought together arguments of managerial intentionality, path dependence, and environmental effects to explain firms' decision to offshore product development work. The results confirm that access to qualified personnel offshore is a strong determinant of such decisions, partly driven by a reduction in the supply of science and engineering talent in the US. The idea of cumulative experience building is also validated, although managerial intentionality seems to be a stronger determinant of PD offshoring decisions than firms' past experience with offshoring. Among the strategic objectives that may lead firms to offshore, speed to market is a key factor underlying decisions to offshore portions of their innovation process. Conversely, firms with growth objectives are less likely to offshore PD. Finally, the study offers a clarification of the role of cost savings in explaining innovation offshoring. Firms do see PD offshoring as a unique opportunity to reduce the cost of their innovation activities partly through HBR strategies with labor arbitrage becoming a secondary driver. For small companies, access to lower cost S&E talent globally enables them to augment their limited in-house R&D resources (HBA strategies).

This paper contributes to the debate about growing shortage of technical talent and globalization of human capital, by providing empirical support to the argument of an impending global race for science and engineering talent triggered by events such as the 2003 cutback in the H1B visa quota from 195,000 to 65,000 visas annually and the diminishing interest in entering the S&E careers as indicated by the decline in the number of US nationals earning advanced degrees in S&E. However, competing for science and engineering talent is unlike seeking markets or production platforms through FDI. Talent is different from other assets because it is highly mobile and because of high obsolescence. Accessing and managing talent in globally dispersed locations requires new recruiting and retention strategies as well as new organizational forms for managing, sharing, and exploiting knowledge.

Although this paper sheds light on a few important questions regarding the determinants of firms' decision to offshore innovation activities, we wish to acknowledge some limitations and future extension of the present research. First, although this paper provides an analysis of the influence of three types of factors on companies' decisions to offshore product development, it is likely that these factors do not impact firms' decisions independently of one another. Some of them are likely to interact. For instance, firms with a low level of previous experience with offshoring may focus more on labor cost reductions objectives, even for product development work, while the effect of access to qualified personnel may be even stronger for more experienced firms. Offshoring PD for increasing speed to market may also be more important to smaller firms, especially in knowledge driven industries (Murtha, 1994). However, testing for all possible interaction effects in an appropriate way would have significantly complicated the model and interpretation of results (Hoetker, 2007). So as a first attempt to bring together managerial intentionality, path dependence and environmental factors for explaining firm offshoring decisions, we chose to focus on a simpler and cleaner model. Moreover, mimetic isomorphic pressures (Di Maggio and Powell, 1983) may also influence decisions by firms to offshore innovative work. As an additional possible path dependence effect, industry-level offshoring experience or even diffusion of offshoring practices at the function-level should therefore also be tested for. Second, the impact of these variables may evolve over time, which would call for a panel data approach instead of a cross-section. At this stage, the main constraint for investigating this limitation is a lack of data. But as the data collection effort of the Offshoring Research Network progresses we should be able to respond to that issue as well. Finally, there is an opportunity for better accounting for the role of the developing pool of talent offshore using data on the availability and quality of S&E professionals in offshore locations. Unfortunately, such data are not readily available and would require a significant effort to construct. Indeed, the widely held assumption that China and India combined offer a seemingly unlimited supply of talents may need to be reexamined as there seems to be a growing shortage of high quality (A and B level) science and engineering graduates in these countries. Moreover, the low level of English language competency in China is a recognized barrier to offshoring innovation work. In sum, it is clear that understanding the dynamics of offshoring innovation, the implication for firm strategy and for national competitive advantage is still in its early phases, and research in these areas is expected to grow in the coming years.

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TABLES TO INSERT IN TEXT

TABLE 1
Sample descriptive statistics

	% of companies	# offshore implementations
Firm size (# employees)		
< 501	24%	208
> 500 < 2,001	8%	68
> 2,000	68%	604
Industry		
Business/IT services	11%	95
FMCG	3%	28
Financial services	17%	152
Health/Biotech/Pharma	4%	35
Manufacturing	15%	135
Other services	14%	123
Professional services	2%	12
Software & Programming	5%	48
Technology	29%	252

TABLE 2
Distribution of offshore implementations across functions and locations

Functions	% of total (N)	Locations	% of total (N)
IT	**26% (227)**	India	42% (366)
Product Development	**26% (230)**	China	11% (98)
Engineering Services	11%	Latin America	8% (74)
R&D	10%	Philippines	8% (71)
Product Design	5%	Western Europe	6% (55)
Administrative	**22% (196)**	Other Asia	6% (54)
Finance & Accounting	12%	Eastern Europe	6% (51)
Human Resources	5%	Canada	5% (40)
Other back office	4%	Other locations	4% (36)
Legal Services	1%	Mexico	4% (35)
Contact Centers	**17% (147)**		
Procurement	**5% (48)**		
Marketing & Sales	**4% (32)**		

TABLE 3
Strategic Drivers of Offshore Implementations (% 4 or 5 on 5 point Likert scale)

	Product development implementations	Non-product development implementations	Chi-squared test
Labor cost savings	91%	90%	0.088 Pr = 0.766
Access to qualified personnel	81%	71%	5.961 Pr = 0.015
Other cost savings	80%	69%	5.195 Pr = 0.023
Growth strategy	77%	69%	3.600 Pr = 0.058
Part of larger global strategy	75%	59%	8.280 Pr = 0.004
Competitive pressures	72%	59%	8.626 Pr = 0.003
Increasing speed to market	57%	41%	12.209 Pr = 0.000
Improving service levels	50%	52%	0.176 Pr = 0.675
Business process redesign	48%	51%	0.411 Pr = 0.521
Adopting an industry practice	41%	42%	0.050 Pr = 0.823
Differentiation strategy	36%	26%	3.738 Pr = 0.053
Access to new markets	32%	15%	21.127 Pr = 0.000
Enhancing system redundancy	28%	27%	0.073 Pr = 0.787

TABLE 4
Percentage (and Frequency) of Offshore Implementations by Industries and Offshore locations

	Product development implementations	Non-product development implementations	% of product development implementations
Industries			
Business/IT services	14% (31)	10% (64)	33%
FMCG	1% (1)	4% (27)	4%
Financial services	7% (16)	21% (136)	11%
Health/Biotech/Pharma	4% (10)	4% (25)	29%
Manufacturing	20% (45)	14% (90)	33%
Other services	7% (17)	16% (106)	14%
Professional services	3% (8)	1% (4)	67%
Software & Programming	10% (23)	4% (25)	48%
Technology	34% (79)	26% (173)	31%
Total	*100%(230)*	*100% (650)*	
Countries			
India	43% (100)	41% (266)	27%
China	19% (43)	8%(55)	44%
Latin America	6% (13)	9% (61)	18%
Philippines	3% (7)	10% (64)	10%
Western Europe	6% (14)	6% (41)	25%
Other Asian regions	8% (18)	6% (36)	33%
Eastern Europe	6% (13)	6% (38)	25%
Canada	3% (7)	5% (33)	18%
Mexico	2% (4)	5% (31)	11%
Other regions	4% (11)	4% (25)	31%
Total	*100% (230)*	*100% (650)*	

TABLE 5
Construction of Variables

Variables	Construction
Dependent	
PD	Dummy = 1 for product development implementations (R&D, product design and engineering services), 0 for other offshore implementations.
Explanatory	
lnSEH1B	Logarithm of sum of number of US nationals Science and Engineering graduates (Masters and PhDs) and of H1B visa quota in year offshore implementation is launched.
PAST_EXP_PD	Number of existing product development offshore implementations of the company when the new offshore implementation is launched.
QUAL_PERS	1 to 5 score attributed to “Access to qualified personnel” as a strategic driver of offshore implementation, as reported in ORN survey.
COST_LABOR	1 to 5 score attributed to “Labor cost savings” as a strategic driver of offshore implementation, as reported in ORN survey.
COST_OTHER	1 to 5 score attributed to “Other cost savings” as a strategic driver of offshore implementation, as reported in ORN survey.
SPEED	1 to 5 score attributed to “Increasing speed to market” as a strategic driver of offshore implementation, as reported in ORN survey.
GROWTH	1 to 5 score attributed to “Growth strategy” as a strategic driver of offshore implementation, as reported in ORN survey.
GLOBAL	1 to 5 score attributed to “Part of a larger global strategy” as a strategic driver of offshore implementation, as reported in ORN survey.
COMPETITION	1 to 5 score attributed to “Competitive pressures” as a strategic driver of offshore implementation, as reported in ORN survey.
Controls	
lnEmpl	Logarithm of number of employees in the company in year offshore implementation is launched.
Captive	Dummy = 1 for captive offshore implementations, 0 otherwise.
D2004	Dummy = 1 for offshore implementations launched in 2004 or after, 0 otherwise.
$Industry_p$ (p = 1 to 7)	7 dummy variables representing industry of operation of the company: Business/IT services, Financial services (reference group), Health/Biotech/Pharma, Manufacturing, Other services, Professional services, Software & programming, and Technology.
$Country_q$ (q = 1 to 9)	9 dummy variables representing the location of the offshore implementation: India, China, Latin America (reference group), Philippines, Western Europe, Other Asian regions, Eastern Europe, Canada, Mexico, Other regions.

Table 6
Descriptive statistics and correlations for explanatory variables

	Variable	Obs	Mean	St.Dev	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13
1	PD	880	0.261	0.440	0	1	1.00												
2	lnSEH1B	487	12.172	0.311	11.82	12.56	-0.08	1.00											
3	PAST_EXP_PD	487	0.585	1.509	0	10	0.08	-0.19*	1.00										
4	QUAL_PERS	649	3.823	0.980	1	5	0.10*	0.03	-0.03	1.00									
5	COST_LABOR	652	4.471	0.823	1	5	-0.08	0.09	-0.23*	-0.05	1.00								
6	COST_OTHER	475	3.844	1.099	1	5	0.11	0.14	-0.07	-0.04	0.38*	1.00							
7	SPEED	651	3.218	1.310	1	5	0.13*	-0.05	0.05	0.09	-0.14*	0.01	1.00						
8	GROWTH	650	3.851	1.054	1	5	0.07	0.09	-0.13*	0.23*	0.12*	0.27*	0.21*	1.00					
9	GLOBAL	471	3.446	1.379	1	5	0.11	0.12	0.13	0.21*	0.02	0.27*	0.43*	0.32*	1.00				
10	COMPETITION	648	3.650	1.140	1	5	0.10	0.028	-0.13*	0.11*	0.12*	0.30*	0.06	0.20*	0.26*	1.00			
11	lnEmpl	913	8.397	3.252	0	12.74	-0.20*	0.05	0.17*	0.10	0.19*	-0.01	0.04	-0.01	0.24*	0.01	1.00		
12	Captive	808	0.490	0.500	0	1	0.12*	0.14*	0.10	0.04	-0.07	0.10	0.05	0.18*	0.24*	0.09	0.12*	1.00	
13	D2003	487	0.581	0.494	0	1	-0.02	-0.43*	0.23*	0.07	-0.12	-0.14	-0.02	-0.07	-0.03	-0.00	-0.04	-0.14*	1.00

Signification level: * <1%

TABLE 7: Estimation Results of Logit Model
Dependent Variable: Probability of Offshoring Product Development Projects

	1	2	3	4	5
lnSEH1B		-0.759* (0.4566)			-0.202 (0.6839)
PAST_EXP_PD			0.192** (0.0934)		0.051 (0.1337)
QUAL_PERS				0.508** (0.2125)	0.514** (0.2137)
COST_LABOR				-0.496** (0.2397)	-0.475* (0.2449)
COST_OTHER				1.079*** (0.2653)	1.075*** (0.2659)
SPEED				0.558*** (0.1497)	0.548*** (0.1507)
GROWTH				-0.440** (0.1982)	-0.443** (0.1984)
GLOBAL				0.138 (0.1754)	0.145 (0.1771)
COMPETITION				-0.208 (0.1646)	-0.194 (0.1691)
Controls					
lnEmpl	-0.145*** (0.0376)	-0.146*** (0.0378)	-0.156*** (0.0382)	-0.107* (0.0614)	-0.112* (0.0630)
Captive	0.755*** (0.2632)	0.768*** (0.2645)	0.669** (0.2667)	0.945** (0.3879)	0.928** (0.3902)
D2003	-0.192 (0.2580)	-0.397 (0.2889)	-0.352 (0.2715)	-0.054 (0.3628)	-0.184 (0.4597)
Business / IT services	2.053*** (0.4631)	1.938*** (0.4686)	2.025*** (0.4673)	2.693*** (0.6799)	2.656*** (0.6853)
Health / Biotech / Pharma	1.289* (0.6729)	1.083+ (0.6832)	1.286* (0.6799)	2.604*** (0.8945)	2.547*** (0.9065)
Manufacturing	1.641*** (0.4690)	1.574*** (0.4720)	1.474*** (0.4813)	1.861*** (0.7136)	1.756** (0.7732)
Professional services	2.319*** (0.8131)	2.219*** (0.8255)	2.3441*** (0.8160)	-	-
Other services	0.546 (0.4881)	0.477 (0.4896)	0.570 (0.4926)	1.498** (0.7194)	1.507** (0.7214)
Software & programming	1.615*** (0.5378)	1.577*** (0.5404)	1.560*** (0.5426)	4.455*** (1.1843)	4.359*** (1.2034)
Technology	1.056*** (0.4016)	1.039*** (0.4043)	1.060*** (0.4066)	1.829*** (0.6583)	1.802*** (0.6632)
China	1.623*** (0.5463)	1.665*** (0.5498)	1.536*** (0.5483)	0.726 (0.7628)	0.712 (0.7605)
India	0.587 (0.4824)	0.599 (0.4840)	0.563 (0.4832)	0.050 (0.6671)	0.056 (0.6679)
Canada	0.774 (0.7515)	0.800 (0.7497)	0.737 (0.7524)	0.866 (1.1658)	0.853 (1.1535)
Mexico	-0.146 (0.9163)	-0.142 (0.9202)	-0.103 (0.9153)	-0.857 (1.3534)	-0.844 (1.3493)
Philippines	-1.959* (1.1269)	-1.984* (1.1280)	-2.320** (1.1609)	-1.878+ (1.2481)	-2.009 (1.2933)
Eastern Europe	0.024 (0.6981)	0.114 (0.6982)	0.009 (0.7041)	0.089 (0.9220)	0.115 (0.9216)
Western Europe	0.806 (0.6122)	0.794 (0.6167)	0.726 (0.6165)	0.289 (0.8711)	0.265 (0.8727)
Other Asian regions	1.184* (0.6317)	1.170* (0.6382)	1.151* (0.6352)	-0.010 (0.9027)	-0.039 (0.9096)
Other regions	0.116 (0.8775)	0.028 (0.8872)	0.019 (0.8917)	0.141 (1.0814)	0.149 (1.0958)
Constant	-1.827*** (0.5724)	7.560 (5.6663)	-1.652*** (0.5753)	-6.622*** (1.7661)	-4.184 (8.5753)
N	476	476	476	315	315
LR chi^2	103.64	106.47	107.95	107.68	107.94
Prob>chi^2	0.0000	0.0000	0.0000	0.0000	0.0000
Log likelihood	-221.205	-219.792	-219.050	-123.567	-123.440
McKelvey & Zavoina R^2	0.369	0.379	0.387	0.537	0.540
McFadden's R^2	0.1898	0.1950	0.1977	0.3035	0.3042

Standard Errors in brackets. Significance levels: *** <1%, ** < 5%, * < 10%, +<15%.
- The dummy for Professional Services has been dropped due to collinearity.

TABLE 8: Odds Ratios of Logit Model
Dependent Variable: Probability of Offshoring Product Development Projects

	1	2	3	4	5
lnSEH1B		0.468* (0.2137)			0.817 (0.5589)
PAST_EXP_PD			1.212** (0.1132)		1.052 (0.1407)
QUAL_PERS				1.661** (0.3530)	1.672** (0.3574)
COST_LABOR				0.609** (0.1461)	0.622* (0.1523)
COST_OTHER				2.943*** (0.7806)	2.931*** (0.7792)
SPEED				1.747*** (0.2615)	1.730*** (0.2607)
GROWTH				0.644** (0.1276)	0.642** (0.1274)
GLOBAL				1.1478 (0.2013)	1.156 (0.2048)
COMPETITION				0.812 (0.1337)	0.824 (0.1394)
N	476	476	476	315	315
LR chi^2	103.64	106.47	107.95	107.68	107.94
Prob>chi^2	0.0000	0.0000	0.0000	0.0000	0.0000
Log likelihood	-221.205	-219.792	-219.050	-123.567	-123.440
McKelvey & Zavoina R^2	0.369	0.379	0.387	0.537	0.540
McFadden's R^2	0.1898	0.1950	0.1977	0.3035	0.3042

Standard Errors in brackets. Significance levels: *** <1%, ** < 5%, * < 10%, +<15%.
Control variables and constant included but not reported.

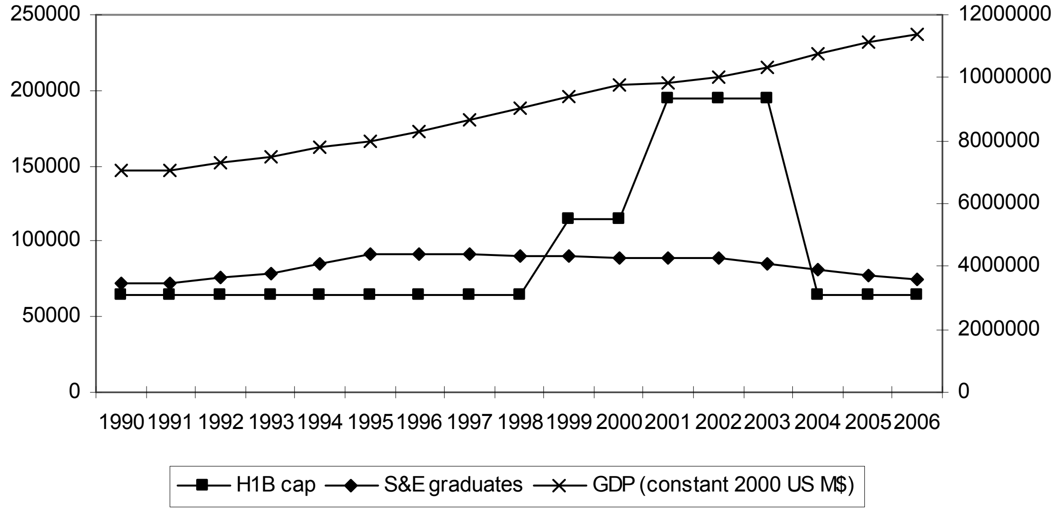
TABLE 9: Estimation Results of Logit Model (pre and post 2003 sub-samples)
Dependent Variable: Probability of Offshoring Product Development Projects

	[1990-2002]	Odds-ratios	[2003-2006]	Odds-ratios
PAST_EXP_PD	-0.057 (0.8513)	0.944	0.076 (0.5689)	1.079
lnSEH1B	-0.204 (0.8434)	0.815	-0.690 (0.4202)	0.502
QUAL_PERS	-0.107 (0.6777)	0.505**	1.549 (0.0000)***	4.708 ***
COST_LABOR	-0.683 (0.0400)**	1.679 *	-0.350 (0.2010)	0.705
COST_OTHER	0.518 (0.0789)*	1.944***	0.890 (0.0036)***	2.434***
SPEED	0.665 (0.0087)***	0.651	0.394 (0.0303)**	1.484**
GROWTH	-0.429 (0.1374)+	0.834+	-0.426 (0.0864)*	0.653*
GLOBAL	-0.181 (0.4208)	0.777	0.610 (0.0054)***	1.840***
COMPETITION	-0.252 (0.2521)	0.899	-0.220 (0.3659)	0.802
Controls				
lnEmpl	-0.234 (0.0131)**	0.791**	-0.250 (0.0006)***	0.779 (0.0006)***
India	0.240 (0.6970)	1.271	-0.002 (0.9963)	0.998 (0.9963)
China	1.297 (0.0847)*	3.657*	0.853 (0.2338)	2.348 (0.2338)
tech_ind	2.262 (0.0012)***	9.605***	0.422 (0.4191)	1.525 (0.4191)
Constant	3.927 (0.7581)		-0.766 (0.9402)	
N	127		191	
LR chi^2	38.99		70.37	
Prob>chi^2	0.0002		0.0000	
Log likelihood	-53.264117		-71.391338	
McKelvey & Zavoina R^2	0.464		0.611	
McFadden's R^2	0.2679		0.3301	

P-values in brackets. Significance levels: *** <1%, ** < 5%, * < 10%, +<15%.
Tech_ind = Dummy variable equals to 1 for Health/Biotech/Pharma, Manufacturing, Software & Programming, Technology; 0 otherwise.

FIGURES TO INSERT IN TEXT

FIGURE 1
Shortage of technical talent in the US and change in visa policy



Data on Master and PhD degrees in sciences and engineering come from the US National Science Foundation. Data for H1B visa quota come from the US Citizenship and Immigration Services.

FIGURE 2
Cumulative percentage of firms initiating offshoring of functional category (1990-2006)