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Internationalization of R&D in two high-tech clusters and cooperation of R&D units in those clusters

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Abstract: In the paper, we present how transnational corporations (TNCs) internationalize their R&D and how they allocate foreign R&D units in high-tech clusters, where competitors of these TNCs, research and academic institutions, and suppliers of these TNCs are also located. We confront two paradigms of R&D internationalization (traditional and new one) and we determine what are the main motives that drive R&D internationalization of TNCs. Based on a modern innovation theory, we derive a cluster approach as a specific method of analyzing modern R&D internationalization. We then present an analysis of two high-tech clusters (Cambridge, Bangalore) and we show that some TNCs allocate their foreign R&D units into those clusters, in order to make use of available external knowledge from academic institutions through intensive R&D collaborations.

Keywords: transnational corporations, R&D internationalization, clusters, R&D collaboration

1 Introduction to R&D internationalization

Internationalization of R&D has become a major topic in business community, and also among academic researchers and government officials. Transnational corporations (hereafter, TNCs) carry out the largest share of global R&D activities and TNCs are main actors in R&D internationalization. R&D internationalization first

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appeared already in the 19th century and it started to accelerate in 1960s. R&D internationalization tends to concentrate in developed countries, with the exception of fast developing countries such as China and India. More than 4/5 of 700 R&D most intensive companies originate from 5 countries (USA, Japan, Germany, Great Britain and France). R&D internationalization can be carried out in many ways, it can run in many directions and it can involve many different types of actors. The most common way of internationalizing R&D is through green-field investments of TNCs abroad.

Until now, researchers have detected up to 20 different reasons for R&D internationalization. According to the old way of seeing R&D internationalization (an old paradigm), the most important reason for R&D internationalization is to adjust products to foreign markets and to support foreign units that are owned by a TNC abroad. Such understanding of R&D internationalization is becoming more and more insufficient and obsolete. In the last years, a new way of comprehending R&D internationalization has thus been developed (a new paradigm). According to this new understanding, the most important reason for R&D internationalization is to increase internal knowledge base of companies. Companies acquire this new knowledge by carrying out R&D in those countries, where many high-tech and innovation driven companies and research organizations reside that provide necessary new knowledge, skills, and business opportunities.

In the paper, we will combine this new paradigm of R&D internationalization with modern innovation theory, in which cluster approach plays an important role. We will then analyze R&D internationalization through cluster approach (methodology) on the basis of two clusters – Cambridge (GB) and Bangalore (India). In the analysis of these two clusters, we will try to answer the following two research questions:

- Do TNCs locate their foreign R&D units in high-tech clusters?
- If TNCs locate their foreign R&D units in high-tech clusters, do these R&D units collaborate with other companies, research and academic institutions in a cluster?

In conclusions, we will summarize our main findings.

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2 A new paradigm of R&D internationalization

Due to accelerated growth of general R&D internationalization that began in the mid-1980s, traditional research paradigm on R&D internationalization became more and more incapable of explaining R&D internationalization phenomenon. During the 1990s, R&D strategies and international locations decisions of transnational corporations have changed substantially (Gerybadze & Reger, 1999, p. 251). Therefore, a new paradigm of R&D internationalization has emerged that provides a better explanation of R&D internationalization and which complements and transcends findings of traditional paradigm. Researchers, belonging to the new paradigm (e.g. Florida, Kuemmerle, Pearce, Cantwell and Janne), all stress that the deciding factor in R&D internationalization is the need of companies to increase their knowledge base ("global sourcing" in research and technologies). Competitiveness of companies is becoming more and more dependent on their ability to be present at many locations, where they can make use of available new knowledge and skills (Le Bas & Sierra, 2002). The reason why TNCs internationalize their R&D is to acquire new or complementary advantages that help them maintain and upgrade their global competitive capabilities. R&D internationalization is therefore driven by the inability of TNCs to create all necessary capabilities all by themselves, for which they think are necessary for protection and development of their global competitive position. The main factor of R&D internationalization are no longer special TNC advantages, but innovation centers in host countries, through which TNCs acquire and develop new capabilities (*ibid*.).

Foreign R&D units of TNCs are becoming increasingly technology- and innovation-driven, their aim is to compensate for technological weaknesses in their home country. These units focus on basic or/and applied research that reflects technological specialization and scientific results of a host country. Increasing strategic role of foreign R&D units thereby complements other parts of global R&D programme of TNCs, where each foreign R&D unit embodies specialization and special scientific capabilities of a particular host country. Foreign R&D units are also means of controlling engineering and design activities of TNCs' competitors. These units are constantly seeking new opportunities; they are engaged in research marketing and advanced production. In the process of R&D internationalization,

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TNCs also have to complement their controlling of territorially dispersed opportunities by internal learning and competence building.

Today, there are many technology and innovation centers in the world (mostly in the USA, EU, Japan, and China). These centers are subjected to severe technological and industrial competition. Leading companies that base their success on R&D have to be therefore present in more than one R&D and innovation centre. By being present at several high-tech R&D locations, TNCs enhance their absorption capacities and are able to quickly respond to massive changes in relative location advantages (Gerybadze & Reger, 1999). A new important factor in R&D internationalization is also a development of advanced national innovation systems and markets, especially in the OECD countries.

Cantwell in Janne (1999) link R&D internationalization to the so called ''technology diversification''. New technologies are becoming increasingly complex and TNCs have to therefore expand their technology and innovation activities abroad if they want to improve technological development even in their primary fields of interests and competitive advantages. Technology diversification also refers to the important development of national innovation systems which is leading to increasingly narrow technological and research specialization of countries. In their global strategies, TNCs tend to internationalize R&D to acquire access to complementary paths of technology development.

3 Modern innovation theory and cluster approach

According to the modern innovation theory (hereafter, MIT), innovations and upgrading of production capabilities are processes that are most successfully implemented inside networks, where there is a strong interaction between 'producers' and 'consumers' of knowledge. Innovations are seen as an evolutionary and social process of common learning. According to the MIT, the nature of technology is 'cumulative' and 'contextual' and is thus specific for a particular company or a country. Because of this cumulative and contextual nature of knowledge and technology, a geographical vicinity of innovation activities is important – geographically determined knowledge spillovers. The best way of implementing knowledge transfer and spillovers are thus immediate, regular and personal contacts (Cantwell & Janne, 1999). Innovation activity is thus being

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geographically accumulated on locations that guarantee 'economies of agglomeration' that increase and facilitate innovation activities.

Innovation process can be investigated in many ways. For MIT, approaches are characteristic that are based on a concept of innovation systems (system analysis). In the last years, a concept of cluster (beside the concept of national innovation system) has been favored in innovations and innovation systems research. The concept of cluster belongs to the group of approaches that are based on the concept of innovation systems (system analysis). Clusters are "networks of production of strongly interdependent firms (including specialized suppliers) linked to each other in a value-adding production chain. In some cases, clusters also encompass strategic alliances with universities, research institutes, knowledge-intensive business services, bridging institutions (brokers, consultants) and customers" (OECD, 1999, p. 9). Clusters are "often cross-sectoral (vertical and/or lateral) networks, made up of dissimilar and complementary firms specializing around a specific link or knowledge base in the value chain" (*ibid*., p. 12). The concept of cluster focuses on connections and inter-dependencies between participants along the value added chain in production and innovations. The cluster concept thus reaches beyond simple horizontal networks and collaborations, in which companies, that are active on the same market of final products, engage in R&D collaboration, joint marketing or supply strategies.

According to Michael Porter (1990), the basis of a cluster is exchange and flow of information about needs, techniques and technologies between buyers, suppliers and related institutions. One of the world's most known clusters are Silicon Valley (USA), Hsinchu Science Park (Taiwan), Napa Valley (USA), Cambridge (GB), Bangalore (India), Hollywood (USA), ICT cluster in Finland, ICT cluster in Flanders (Belgium).

In many countries and industries, clusters are basis for innovation activities and therefore one of the key factors of economic growth and employment. According to Porter (1990), clustering is the fundamental trait of developed economies. High-tech and highly innovative clusters attract especially new technologies, skilled labor force and R&D investments. Innovation process in such clusters is carried out through strong links between suppliers and users along the value added chain. The fundamental factor for successful innovation activities in clusters is collaboration

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among companies and related institutions, which reduces costs (it can be cheaper to acquire new knowledge and technology from external sources than to create it inside a company), it increases learning opportunities, it enables sharing of R&D costs and risks, and it sometimes even reduces time that is necessary for the introduction of new products and processes on the market (*ibid*.). Clusters stimulate investments and specialization. Joint projects by companies from different industries are common – these projects are carried out in the framework of various trade associations in a cluster. Because of these intensive collaborations, universities and governments tend to be more involved in clusters, educated, skilled and talented workers tend to apply for work in clusters, and all this enhances reputation of clusters and countries, where these clusters reside.

The most important conditions for cluster formation are (Porter, 1990):

- critical mass of firms allowing economies of scale and scope,
- a strong science and technology base,
- a culture conducive to innovation and entrepreneurship.

Other factors that are also important for cluster formations are natural resources or geographical advantages. Many successful clusters have long historical roots, and the emergence of new clusters takes time (Porter, 1990).

Clusters exist in a variety of forms and they can be categorized according to different criteria. According to R&D intensity, for example, we can roughly distinguish between low-technology (low levels of R&D activities) and high-technology clusters (high levels of R&D activities). Lorenzen and Mahnke (2002: 6) name these high-techs, highly innovative clusters "knowledge clusters" that include "technology leading firms, highly skilled labor (often engineers) and knowledge institutions (typically universities and research facilities)."

For the purposes of our analysis, we decided to make an analysis of two high-tech clusters, one of them being in a highly developed economy (GB), and the other in a rapidly developing economy (India). In analyzing these two clusters, we tried to get answers to the following two main questions:

- Do TNCs locate their foreign R&D units in high-tech clusters?

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- If TNCs locate their foreign R&D units in high-tech clusters, do these R&D units collaborate with other companies, research and academic institutions in a cluster?

4 Cambridge cluster

Cambridge cluster is one of the innovation centers in Great Britain – other innovation centers are London, Oxford, Reading, Thames Valley, Glasgow and Edinburg. In The Cambridge Cluster Report 2004, the Library House company found out that an ''increasingly open culture has seen Cambridge University become a leading centre for industrial research laboratories with concomitant investments from major corporations such as AT&T, GlaxoSmithKline, Hitachi, Intel, Microsoft, Olivetti, Oracle, The Wellcome Trust, Toshiba, and others over the past twenty years'' (Library House, 2004). On its internet pages, the Silicon Fen Business Report company (2007) published at least 19 foreign TNCs that have positioned their R&D units in the Cambridge cluster. These TNCs are Accelrys, Azuro, Bayer CropScience, Corbett Research, Ember, Epson, Hitachi, Intel, Kerio Technologies, Keronite, Kodak, Solarflare Communications, LION Bioscience, Microsoft, NCT, Owlstone Nanotech, Syngene, Toshiba and Trinity Convergence.

Silicon Fen Business Report (2007) reported that R&D units of some foreign TNCs collaborate with research institutions in the Cambridge cluster. These TNCs are Hitachi, Intel and Microsoft. In the following, we will present R&D collaboration of these TNCs with research organizations in the Cambridge cluster.

4.1 Hitachi Cambridge Laboratory

Hitachi Cambridge Laboratory is an international group of researchers that intensively collaborates with the Microelectronics Research Centre of the Cambridge University. Openness of Hitachi Cambridge Laboratory towards collaborative R&D has been creating profitable collaborations for Hitachi. Hitachi Cambridge Laboratory is part of Hitachi's global R&D and it intensively collaborates with other Hitachi research laboratories in Japan and in other parts of the world.

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4.2 Intel Research Cambridge Lab

Intel Research Cambridge is one of four laboratories in the Intel Research Network of University Labs. This network is an innovative model of industry-university research with enhancing results of long-term research projects and with stimulating collaborations with public research institutions (Intel, 2007c). Intel Research Cambridge was established in 2002, in order to carry out open research in collaboration with universities in the UK and in the EU. Intel Research Cambridge laboratory is located at the Cambridge University campus, near to the Computer Laboratory (university department for computing) and near to the Department of Engineering, with which Intel researches intensely collaborate.

Open and cooperative research model (OCR) that stimulates open distribution of research results enables collaborative R&D that is carried out in Intel Research Cambridge. This model was built in order to avoid typical disagreements concerning intellectual property rights – these disagreements impede or even render impossible many traditional industry-university collaborations. For each laboratory in the Intel Research Network of University Labs, this model enables free and simple collaboration with university researchers, without having to draft long and complicated legal agreements.

Intel Research Cambridge laboratory finances and provides help in various forms to students and university researches, including internship and access to the laboratory and Intel resources. Intel Research Cambridge laboratory offers rooms for research, it offers offices, it carries out seminars where students and university researchers can participate, and finally, researchers from the Intel Research Cambridge laboratory teach at the Cambridge University and they give counsel to students. In this way, students and university researchers intensively acquire knowledge about Intel and its researchers and they develop their own research programmes.

Intel Research Cambridge laboratory offers real, concrete experiences of a large company, which complements academic background of students and university researchers. Professor Ian Leslie, Pro Vice Chancellor for Research at the University of Cambridge says that one of the benefits of collaborating with Intel is that the university's researchers have access to the current thinking in industry and get a

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sense of what is possible, "so that their research ideas and solutions are grounded in reality" (Intel, 2007c).

In exchange for money, help and entrepreneurial research experiences through Intel Research Cambridge laboratory activities, Intel gets access to some of the world's best students and university researchers that live and work in the vicinity. This physical vicinity enables easier and more effective communication and collaboration. Ian Leslie says that Intel Research Cambridge laboratory presence in the campus enables different informal information exchanges that are often more productive than formal organized meetings. Researchers from different laboratories can regularly meet; they can discover common research interests and then implement them.

4.3 Microsoft Research Cambridge Laboratory

Microsoft Research Cambridge Laboratory was established in 1997 and has today more than 100 leading researchers, mostly from Europe. Microsoft decided to locate its research laboratory in the city of Cambridge because of its world-renowned reputation and rich history as a center of learning (Microsoft, 2009).

Microsoft Research Cambridge is one of the largest computer science research laboratories in Europe, the Middle East and Africa (EMEA). "While a proportion of the research projects either contribute to products or become products in their own right, the majority of the work undertaken is longer term "blue sky" pure research. By adopting this approach, researchers can innovate freely in an environment that is not governed by product life cycles and the constraints of project management" (Microsoft, 2009).

Microsoft Research Cambridge has also established a Research Partnership Programme, the aim of which is to "facilitate collaboration between researchers, Microsoft teams across EMEA and key industry partners and clients" (Microsoft, 2007). In the framework of this programme, Microsoft Research Cambridge laboratory is engaged in collaborative projects with the University of Southampton, industry partners, public organizations and EU projects (e.g. PLANETS). Laboratory offers PhD students in the field of Computer Science internship opportunities. Laboratory intensively collaborates with the computer laboratory, engineering

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department and statistics laboratory of the Cambridge University (Silicon Fen, 2007).

5 ICT cluster Bangalore, India

ICT cluster Bangalore is the most important cluster in India. In the Bangalore ICT cluster, many TNCs are present and by means of their operations, they contribute to the cluster growth. According to the study, carried out by the Administrative Staff College of India (Basant, 2006), at least 77 foreign TNCs have established their R&D units directly as subsidiaries in India until now. Many other foreign TNCs have engaged themselves in R&D alliances or they have out-sourced parts of their R&D to local Indian companies. The majority of foreign R&D units of TNCs in India are in Bangalore; out of 77 R&D centers of foreign TNCs, almost 40 of them are in or around the ICT Bangalore cluster. Ramachandran and Ray (Ramachandran & Ray, 2003) also concluded that "overseas companies opened software centers in India to strengthen interaction between their organizations and Indian suppliers. By 2001, several MNCs had R&D subsidiaries too, in Bangalore."

Foreign TNCs in the Bangalore ICT cluster collaborate with companies and education institutions that also operate in the cluster. In this way, TNCs can receive information about specific software types, about generic principles and about organization methods. Companies participate in the Software Productivity Improvement Network, i.e., in the group of 10 large companies that share information about software practices and "benchmarking". Almost all domestic and foreign companies that are operating in Indian software technology parks, collaborate with research laboratories or institutes in Bangalore. These institutes give companies new ideas for improving existing products and for producing new ones. Collaboration between research and education institutions is very diverse in the Bangalore ICT cluster. Local research and education institutions provide well-educated and skilled workers and useful knowledge. Foreign TNCs in the Bangalore ICT cluster provide increasing amount of money for R&D and they make increasing amount of patents (Basant, 2006).

Research activities of foreign TNCs in the Bangalore ICT cluster correspond to the new paradigm of R&D internationalization, according to which TNCs locate their foreign R&D units in high-tech clusters and these units then collaborate with other

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research institutions and companies in the cluster. In the following, we will present R&D collaboration of some foreign TNCs with research organizations in the Bangalore ICT cluster.

5.1 HP Labs Bangalore, India

HP Labs Bangalore is part of a larger HP Labs India that "supports open innovation by working collaboratively with various academic institutions. The collaborations include joint PhD Fellowships, sponsored research students and sponsored research projects" (HP, 2007).

HP Labs India regularly collaborates with the best Indian academic organizations, such as Amrita University, BITS Pilani, IISc (Bangalore), IIIT (Bangalore), IIIT (Hyderabad), Sri Sathya Sai Institute of Higher Learning (Prasanthi Nilayam). This collaboration includes joint scholarships for PhD students, sponsorships for researchers and research projects. HP Labs India also collaborates with the International Institute of Information Technology, Bangalore (IIITB). This institute is a new generation Graduate School focusing on all aspects of information technology. IIITB and HP Labs India jointly offer a unique PhD fellowship for research in Information Technologies. This fellowship was instituted to attract candidates of exceptional abilities for research. It offers candidates an opportunity to work to the highest academic standards.

5.2 IBM India Research Laboratory, Bangalore

IBM India Research Laboratory was established in 1998 in New Delhi as the eighth IBM research laboratory. In 2005, this laboratory moved to Bangalore, where IBM Global Services are also present. IBM Research – India was established in order to "advance state-of-the-art breakthroughs in IT through research in software and services, and to provide leadership by delivering innovations to IBM's clients globally" (IBM, 2007a).

IBM Research – India collaborates intensively with Indian universities. IBM Research – India's goal is to "develop long-term, mutually beneficial relationships with Indian academia by fostering advanced research, promoting academic exchanges, and cultivating tomorrow's world-class researchers" (IBM, 2007b). IBM Research – India's university relations efforts center on "encouraging well-defined,

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researcher-to-researcher collaborative relationships between individual faculty members and IBM Research – India researchers" (*ibid*.). These collaborations include research awards, research grants, equipment grants, sabbatical opportunities, conference sponsorships, student internships, student project training and others. IBM Research – India's university collaborations are open to many Indian and foreign universities.

IBM Research – India has introduced a Student Travel Programme which finances undergraduate students at six Indian research and education institutions, one of them being Indian Institute of Science in Bangalore (IBM finances, for example, a presentation of students' research results at international conferences). IBM Research – India also awards the best PhD students.

In Bangalore, IBM has also established the Centre for Advanced Studies, in order for IBM workers to collaborate with the best Indian engineering institutions. This centre gives students from leading Indian engineering institutes access to IBM research, technical staff and other resources, in order to then find solutions for important software research problems (Basant, 2006).

5.3 Intel India Research Center

Intel India Research Center is composed of 2 laboratories: one is Bangalore Design Labs and the other is Systems Research Center. Intel R&D centre in Bangalore was established in 1998. At that time, 20 engineers worked at the centre, while in 2006, already 1.400 e-commerce engineers were working there (Basant, 2006).

Intel India Research Center collaborates intensively with Indian research community, in order to support quality research. The centre finances, for example, the best graduate students during the time of their schooling. The centre also finances research projects; it provides money to researchers from academia for international conferences where they present their research. And finally, the centre offers help and provides directions for curricula at the Indian education institutions (Intel, 2007a).

Together with Intel Higher Education – India and many other special interest groups, Intel India Research Center seeks and supports research at Indian institutes. Intel Research & Development Group is an inner group of technical

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experts that focus on basic research in many fields. This group collaborates with Indian universities, in order to enhance basic research (Intel, 2007b). Intel, together with Nokia, collaborates with the Indian Institute of Science in Bangalore (Basant, 2006).

6 Key findings

The purpose of this paper was to present a cluster analysis of contemporary R&D internationalization, carried out by TNCs. The analysis showed that, first, some of the world's largest TNCs locate their foreign R&D units into high-tech clusters, such as Cambridge and Bangalore, and second, these foreign R&D units of TNCs collaborate with other cluster participants, i.e. research and education institutions and companies. TNCs carry out this kind of R&D internationalization, in order to enhance their blue sky and applied research and to extract new knowledge, ideas and skills, by means of which they can successfully innovate and compete at the world market. Cambridge and Bangalore clusters thus show correspondence with the new paradigm of R&D internationalization, which has become a valid explanation of contemporary R&D internationalization.

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