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Offshoring of R&D activities by Multinational Corporations

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DEDICATION

To my wife Bahtinur Hediye and my son Nur-Ali

You encouraged me to dream and gave me the courage to pursue those dreams.

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ABSTRACT

Offshoring of high value activities is a comparatively recent phenomenon that has become increasingly significant in the last two decades (Manning et al. 2008). According to international business theories, companies must keep control of their high value activities, such as research and development (R&D) and information technology (IT), that give them competitive advantage over other firms (Blinder, 2006; Farrell, 2005a). However, these high value activities have become more geographically dispersed in recent decades (Contractor, Kumar, Kundu, & Pedersen, 2010). Cross-fertilization of technologies across disciplines and recent technological diversification of companies, which are accepted as the latest shift in the technological revolution and techno-economic paradigm, have stimulated the process of R&D offshoring (Narula, 2001). Improvement in the institutional environments and government policies in emerging countries, fierce competition in the global market, and increase in costs and risks of doing R&D in developed countries are a few factors that have influenced the offshoring of R&D activities. According to Contractor et al. (2010), the determinants that have led to the increase in offshoring of R&D activities are improvements in information communication technologies (ICT) as well as in social and economic resources, which have provided better infrastructure in host countries. Increased uniformity in international patenting has also played an important role in offshoring of R&D activities.

This thesis attempts to extend the current understanding of the R&D offshoring process with specific focus on determinants of location choice for R&D activities. The literature dealing with the determinants of location choice is largely fragmented and hence this thesis attempts to integrate the different prevailing perspectives. Based on transactional cost economics, resource-based view and eclectic paradigm, this thesis adopts a multi-level approach to

examine country, firm and project level factors of location choice decision. Moreover, this study investigates the difference between the degree of innovativeness and routineness of R&D activities offshored to developed and emerging countries. Furthermore, it also looks at the difference between the degree of innovativeness and routineness of R&D activities offshored to foreign affiliate and non-integrated suppliers.

In order to attain the objectives of thesis self-administered questionnaire was distributed to 941 Multinational Corporation located in UK and 126 responses were collected. Furthermore, Multinomial Logistic Regression was adopted for the analysis which was also supplemented with PLS modeling to validate the measurement and structural models separately.

The analysis indicates that country level determinants such as cost, human capital, national innovation system (NIS), country risk and cultural difference significantly affect the location choice decision of R&D offshoring. While the company level factors such as experience and reputation of the firm show the significant effect on location choice decision, the results of the analysis do not support the hypothesis which suggests that the capability of the host firm has an influence on location choice decision. The analysis also demonstrates that the characteristics of projects, such as speed, quality, interactivity, innovativeness, and routineness, also affect the location choice decision. Only the hypothesis relating to the classification of R&D projects was not supported by the analysis of data. The study also shows that the degree of innovativeness of R&D activities offshored to developed countries and foreign affiliates is higher than the degree of innovativeness of R&D activities offshored to emerging countries and non-integrated suppliers. However, the degree of routineness of R&D activities offshored to developed countries and foreign affiliates is lower than that to emerging countries and non-integrated suppliers.

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CHAPTER 1 – INTRODUCTION

The introduction to this thesis covers some of the key aspects pertaining to the background of research and the research objectives arising from the same. This chapter throws light on the contributions made by this study and further outlines the structure of this thesis.

Research background

Offshoring of activities is a recent phenomenon and has become increasingly important in the last few decades as a result of the digital revolution and the impressive fall in information and communication costs, which have created opportunities for firms to take advantage of high-skilled, low-wage employees in emerging markets (Blinder, 2006; Farrell, 2005a). Over the last decade international organizations (OECD, 2007; UNCTAD, 2005) have reported that Multinational Corporations (MNCs) have increased the amount of offshored activities to low-cost countries, particularly to China and India. Conventionally, firms try to keep control over their core activities, which give them competitive advantage in the market. However, the offshoring of core activities, such as information technology (IT) and research and development (R&D), is gradually increasing and becoming more geographically dispersed (Gammeltoft, 2005). According to Manning et al. (2008), IT and new product development – including product design, engineering services, and R&D – were the most frequently offshored firm activities.

In the past decade, offshoring has received much attention from the mass media, despite a fairly long history of firm internationalization. Many authors (Kshetri, 2007; Rilla & Squicciarini, 2011) argue that this is mainly due to fears about job losses in the country of origin of the firms. According to Wall Street Journal, approximately 40 million American jobs are at risk of being moved out of the country in the next decade or two (Doh, Bunyaratavej, & Hahn, 2009). However, Farrell (2005a) claims that the job losses associated with the offshoring of activities accounts for only 4 per cent of all US job losses. She also highlights that more than 130 million people are employed by the US economy today and 35 million new jobs have been created in the last ten years. As the economy grows, some of the job types shrink, or even disappear, while new ones are created: auto assemblers superseded carriage makers, and factory workers superseded farmers. The same process takes place again as jobs in back-office operations, call centers, and some IT activities are offshored across borders. Opportunities to redeploy labor and invest capital to generate high value added jobs will appear, even if it cannot be predicted precisely where (Farrell, Laboissière, & Rosenfeld, 2006). So, Farrell (2005b) argues that the economy of the US can compensate the offshoring job losses by creating new jobs. Moreover, it should be highlighted that the large majority of jobs in developed countries are in service industries such as personal care, catering and retailing. This work by its nature cannot be moved abroad. Even in good times, layoffs far exceed the job losses predicted from offshoring (Farrell, 2004). Furthermore, developed countries face a coming labor shortage due to an aging population. According to research by UNCTAD (2005) on demographic trends around the world, the population of Western Europe will decline by approximately 11-12 per cent by 2025, and the share of working-age people will decrease from 61 per cent to 53 per cent (UNCTAD, 2005). Therefore, as the developed country population is aging, the governments have no choice but to look abroad for workers to maintain the steady supply of low-cost goods and services the country needs to maintain or increase its standard of living.

In the literature of international business there are different definitions of offshoring. While some authors define offshoring as “the transfer of activities, that had previously been performed in the home country, across national borders" (Rilla & Squicciarini, 2011), others argue that "offshoring is the flow from developed, high-cost countries to low-cost destinations" (Blinder, 2006; Farrell, 2005a). Since a definition of offshoring will be discussed in Chapter 2, I will not deliberate on it here. However, the definition of Lewin, Massini, and Peeters (2009) is crucial and according to them, "offshoring is a new form of internationalization by which firms disaggregate their value chains across multiple locations". So, the starting point of investigating R&D offshoring should be the internationalization of R&D. Based on R&D internationalization research, it is clear that internationalization of R&D activities is not a new phenomenon (Granstrand, 1999). There is a broad literature in this area starting from the study of Vernon (1966) till nowadays. At the beginning of the Golden Age of Capitalism (the 1960s and 1970s) MNCs have built up foreign manufacturing activities and small R&D labs to adapt home-developed products and technologies to foreign production conditions. In later phases (the 1980s and 1990s), MNCs' objectives were supporting local and global mandate foreign subsidiaries with R&D centers and new technologies (Song & Shin, 2008). Even though the trend towards internationalization of R&D became apparent in the late 1960s and 1970s, it became a widespread phenomenon only in the late 1980s thanks to progress in information and communication technologies that served to connect R&D activities (Florida, 1997; Hakanson & Nobel, 1993). According to Shan and Song (1997), between 1985 and 1993, overseas investment in R&D by US firms tripled, while in the United States, R&D expenses abroad reached 10% of overall R&D investment, up from 6% in 1985. Similarly, the ratio of overseas R&D to total R&D expenditure exceeded 30% for European MNCs in 1995 (Song & Shin, 2008).

Research problem

Granstrand (1999) argues that the recent expansion in the internationalization of R&D is the result of several factors. According to Granstrand (1999), these factors can be categorized into three groups: demand-oriented factors which are related to better serving of foreign markets, supply-oriented factors which enhance the value of existing parent-company technology by providing access to skilled technical expertise, lower cost, access to foreign universities and other research organizations (Granstrand, Hakanson, & Sjolander, 1993), and environmental factors which include government policies such as tax advantages, subsidiaries for R&D, enforcement of government to set up local R&D centers and intellectual property right regulation (Niosi & Godin, 1999).

However, some authors (Florida, 1997; Kuemmerle, 1999) have different ideas in the case of factors. They claim that there are two main causes for the process of R&D internationalization. The first driver is the adaptation of domestic products to local markets (Bunyaratavej, Doh, Hahn, Lewin, & Massini, 2011), which is called "asset-exploiting R&D" (Dunning & Narula, 1995) or "home-base exploiting R&D" (Kuemmerle, 1999). The main focus of this strategy is to adapt home-base R&D to local requirements and closely connect to and locate in proximity of foreign manufacturing and marketing facilities. Establishing R&D centers in close proximity to factories and plants becomes necessary, when MNCs establish foreign manufacturing facilities and appoint increasingly complex products to them. These R&D centers facilitate knowledge transfer and prototypes from the MNC's home location to the actual manufacturing facility (Howells, 1990). A second motive for internationalization of R&D is the need to augment a firm's knowledge base (Florida, 1997; Hakanson & Nobel, 1993), which is called "asset-augmenting R&D" (Dunning & Narula, 1995) or "home-base augmenting R&D" (Kuemmerle, 1999). This strategy requires creating links with host-country R&D institutions and infrastructure to improve the knowledge base at home and to connect more closely to the foreign R&D environment and access local knowledge (Bunyaratavej et al., 2011). Based on asset-augmenting R&D motives, specific nations, cities and R&D clusters stand out as favorable locations for R&D centers because of potential spill overs from the existing R&D institutions in the local environment, e.g., universities, research centers, and innovative competitors (Jensen & Pedersen, 2010).

Gammeltoft (2005) developed the argument of Dunning and Narula (1995) and Kuemmerle (1999), and claimed that there are six types of motives for internationalization of R&D: (1) market-driven to customize products for the specific market; (2) production-driven to locate R&D close to manufacturing facilities (similar to asset-exploiting R&D or home-base exploiting R&D); (3) technology-driven to access and monitor knowledge bases in foreign nations (similar to asset-augmenting R&D or home-base augmenting R&D); (4) innovation-driven to generate new ideas from the foreign environment; (5) cost-driven to access less expensive R&D resources; and (6) policy-driven to satisfy foreign governments that demand local R&D in return for market access.

The importance of the research

The factors argued by Granstrand (1999), drivers claimed by Dunning and Narula (1995) and Kuemmerle (1999), and motives suggested by Gammeltoft (2005) are the main determinants of R&D internationalization; nevertheless, the new wave of offshoring of innovative activities and other business services seems to be driven by multiple reasons, such as technology and innovation, as well as cost. Furthermore, it is plausible that the motives for offshoring evolve over time, supporting a dynamic view of offshoring. At the beginning of the 1990s, the focus of the offshoring process was on transferring manufacturing activities to low-cost countries: however, its complexity and scope have since extended. Nowadays, companies offshore high value-added activities that were traditionally kept in the home country, such as advanced technology design, medical diagnosis and treatment, legal services, or R&D (Stringfellow, Teagarden, & Nie, 2008). The motives for these offshoring processes have also changed with time (Maskell, Pedersen, Petersen, & Dick-Nielsen, 2007). Cost saving was the primary reason for offshoring of activities in the 1990s, while the need for flexibility and access to resources that are unavailable at home are the main determinants of offshoring of high value added activities now (Bunyaratavej, Hahn, & Doh, 2007; Lewin et al., 2009; Manning et al., 2008). Contractor et al. (2010) argue that two strategy motivations have gained significance in recent years: the knowledge-accessing and knowledge-exploiting motive. The complexity of products and services has grown so much that, even the largest MNCs no longer have all the diverse components of knowledge within their own organization, or personnel, to be competitive in research, production and marketing. Organizationally and geographically distant knowledge can often be more valuable than internal or related-party knowledge (Contractor et al., 2010). According to the knowledge-exploiting motive, relocation of activities abroad helps the companies to better understand and exploit foreign markets. Local value-added builds legitimacy with local customers and government (Bunyaratavej et al., 2007). For example, the research center of Danish wind turbine producer Vestas in Singapore created a gateway to the increasingly important Chinese market (Benito, Lunnan, & Tomassen, 2011). Also, Jensen and Pedersen (2011) argue that the recently established research center in Houston, Texas is expected to provide Vestas with a closer connection to the large US market. However, it should not be forgotten that motives are not static and might change over time, so the company might enter a foreign country with a cost saving or an efficiency-seeking motive, but can later expand its activities there to employ local human capital as part of the offshoring strategy.

The recent literature on offshoring mentions that the increasing cross-fertilization of technologies across disciplines, the liberalization of markets, the increased digitalization of value-creating activities, which reduce the difficulties associated with managing distant operations, and the reduction of transaction and transportation costs are important factors which have led to an overall increase in offshoring of R&D (Contractor et al., 2010). According to Rilla and Squicciarini (2011), the factors that facilitated the increase in offshoring of R&D were improvements in governance, economic and social infrastructures of emerging countries, fierce competition in global markets, and the concurrent enhancement in costs and risks of R&D. A broader literature review on determinants and factors which influence the offshoring of R&D will appear in Chapter 2.

One of the most important problems related to offshoring of R&D activities is transferring the created knowledge (Rilla & Squicciarini, 2011). Manning et al. (2008) highlight concerns about the risks associated with weak Intellectual Property Right (IPR) systems. Though several developing countries have taken actions to improve their IPR regimes, concerns about IPR are still topical. A well-constructed and realizable IPR framework benefits both offshoring companies and developed and emerging countries (Hahn, Bunyaratavej, & Doh, 2011). MNCs need to protect their high value added activities from local competitors and foreign firms. Furthermore, an appropriate realizable IPR framework will benefit both home and host country firms, because firms in developing countries are progressively internationalizing their R&D activities (Gassmann & von Zedtwitz, 1999).

Research done in the area of knowledge management reveals that one of the main competitive advantages of MNCs is the ability to create and transfer knowledge. The multinational corporation is considered to be a differentiated network, where knowledge is created in various parts of the MNC and transferred to several inter-related centers (Minbaeva, 2007). Conceptualizing the MNC as a differentiated network has inspired a recent stream of research on the creation, assimilation, and diffusion of internal MNC knowledge emphasizing the role of subsidiaries in these processes (Minbaeva, Pedersen, Bjorkman, Fey, & Park, 2003). A common point is that MNCs can create knowledge in one location but exploit it in other locations, by using the MNCs' internal transfer of knowledge. Therefore, the competitive advantage of MNCs depends on their ability to facilitate and manage inter-subsidiary transfer of knowledge. Ghoshal and Bartlett (1988), for example, focused on how to organize and structure MNCs in order to facilitate the internal flow and transfer of knowledge. The literature on knowledge transfer has proliferated over the last two decades and today much exists. The important parts of this broad literature on knowledge transfer related to our research will be discussed in the Literature Review chapter (Chapter 2).

Research aims and objectives

In this context, the determinants of R&D offshoring and transfer of knowledge between headquarters and subsidiaries are definitely a phenomenon of interest. This is because unlike the vast literature on R&D internationalization, there are still few studies investigating R&D offshoring. This brings us to the research aim which is to examine the determinants of location choice decision for offshoring of R&D activities. Furthermore, the secondary aim of the research is to investigate the innovativeness of the offshored R&D activities by using the transfer of knowledge between headquarters and subsidiaries as a proxy approach.

During the analysis of the research done in the area of R&D offshoring, it was found that there are still a number of gaps in the literature that need to be addressed. The extensive literature on determinants of location choice has primarily focused on country level factors such as cost (Lewin & Peeters, 2006), knowledge infrastructure and legal institutes of host country (Demirbag & Glaister, 2010; Demirbag, Tatoglu, & Glaister, 2010b), political and economic risks of the host country (Demirbag, McGuinness, & Altay, 2010a), and cultural distance between host and home country of MNCs (Bunyaratavej et al., 2007; Doh et al., 2009). Only some studies have examined the firm level factors like R&D networking (Howells, 2008), growth strategy of the company (Rilla & Squicciarini, 2011) and economies of scale and scope (Blinder, 2006). However, there is a lack of research examining the determinants of location choice decision at the project or task level.

In this study, the determinants of location choice decision for R&D offshoring will be investigated separately at country, firm and project levels. Afterwards, all determinants will be integrated into one model and the inter-linkages between these different drivers will be analyzed.

The research done on knowledge transfer is mostly focused on the factors that facilitate or impede knowledge transfer of MNCs and the use of transfer mechanisms in MNCs. There are limited numbers of studies that investigate the performance of knowledge transfer such as Bresman, Birkinshaw, and Nobel (1999) and Pedersen, Petersen, and Sharma (2003). These studies suppose that an important success criterion of knowledge transfer done by MNCs is the right fit between the characteristics of the acquired internationalized knowledge and the MNC's knowledge transfer mechanism. As a result they measure the performance of knowledge transfer by comparing the characteristics of transferred knowledge and transfer mechanism which is accepted as an indirect method of measurement. There is also a lack of studies investigating the innovativeness and routineness of the offshored activities. In this study, knowledge transferred between headquarters of MNCs and subsidiaries will be used as proxy in order to measure the innovativeness and routineness of the offshored R&D activities.

The main objectives of the study are listed below:

1. Examine the influence of determinants on location choice decision of the R&D offshoring process.
    a. Explore the effects of country level, firm level and project level factors on location choice decision of the R&D offshoring process.
    b. Analyze the inter-linkages between these different determinants when it comes to their influence on location choice decision of the R&D offshoring process by integrating all different perspectives.
2. Measure the innovativeness and routineness of offshored R&D activities by using knowledge transferred between headquarters of MNCs and subsidiaries as a proxy approach.

Research Contributions

This study attempts to contribute to the R&D offshoring literature by enhancing our current understanding of the R&D offshoring process and analyzing factors that influence the decision of MNCs when they choose where to offshore R&D activities. Also, the thesis further attempts to support management, economics and international business theories such as transaction cost economics (Williamson, 1985), the resource-based view (Barney, 1991) and the eclectic (OLI) paradigm (Dunning, 1988), that throw light on the importance of determinants and drivers in the R&D offshoring process. Further, by focusing on the project level factors of location choice decision, the thesis tries to deepen the research in this area. It is important to note that prior studies on R&D offshoring have not targeted the project level determinants of location choice decision. The extant R&D offshoring literature has mainly focused on country level factors like labor cost (Lewin & Peeters, 2006), infrastructure and legal environment of the country (Demirbag & Glaister, 2010; Demirbag et al., 2010b), country risks (Demirbag et al., 2010a), cultural differences (Jensen & Pedersen, 2010), while some studies examine the company level factors like R&D networking (Howells, 2008), growth strategy of the company (Rilla & Squicciarini, 2011) and economies of scale and scope (Blinder, 2006). A typical study from R&D offshoring literature mostly focuses on the effect of some of these determinant categories and analyzes the process of location choice with each of these different categories of determinants. This study makes a contribution to the R&D offshoring literature by analyzing location choice decision using a multi-level perspective. This enables the researcher to have a holistic understanding of the phenomenon that calls for an integrative model incorporating the interplay between these aspects, which has also been attempted in this thesis. This also stems from the recent call for multi-level perspectives and analysis in international business (Buckley, Forsans, & Munjal, 2012; Jensen & Pedersen, 2011). Finally, the study also has governmental and managerial implications by way of recommendations that could promote an efficient R&D offshoring process.

Summary and Thesis Outline

To summarize, in this chapter some aspects of the offshoring phenomenon, such as positive and negative sides of job losses in developed countries have been highlighted. It was mentioned about the R&D internationalization process and disputed the motives and trends of this process. Also, it was highlighted that motives for R&D internationalization and R&D offshoring are not static and may change over time. Some determinants of R&D offshoring was discussed and it was mentioned that a broad literature review on determinants of this process will be addressed in the next chapter. Also, some perspectives of knowledge transfer have been argued. Furthermore, the aim and objectives of the research have been stated. And, finally the contribution of this study has been described.

The aim of this chapter was to create an introduction to the research area of my thesis and give some information about it, and also mention the important headlines of my research area. The next chapter will discuss the definition of important concepts such as R&D, offshoring, outsourcing, and internationalization and it will give a final definition of R&D offshoring which will be used in this thesis. Also, Chapter 2 will discuss theories used in offshoring and theoretical perspectives applied for the offshoring process. Furthermore, it will offer a detailed review of offshoring as well as further examine the narrower stream of literature on determinants of R&D offshoring. Drawing on the literature on offshoring of R&D activities, the study puts forth the conceptual models and hypotheses for further analysis of determinants of location choice in Chapter 3. Subsequently, the methodological approach for the study is detailed in Chapter 4 and targets the relevant aspects of sampling, questionnaire development, descriptives, factor analysis, data collection and measures used. Chapter 5 deals with the data analysis, testing of the hypotheses and presents the empirical results of the research. Finally, the discussions, conclusions, implications and limitations of the study are discussed in Chapter 6.

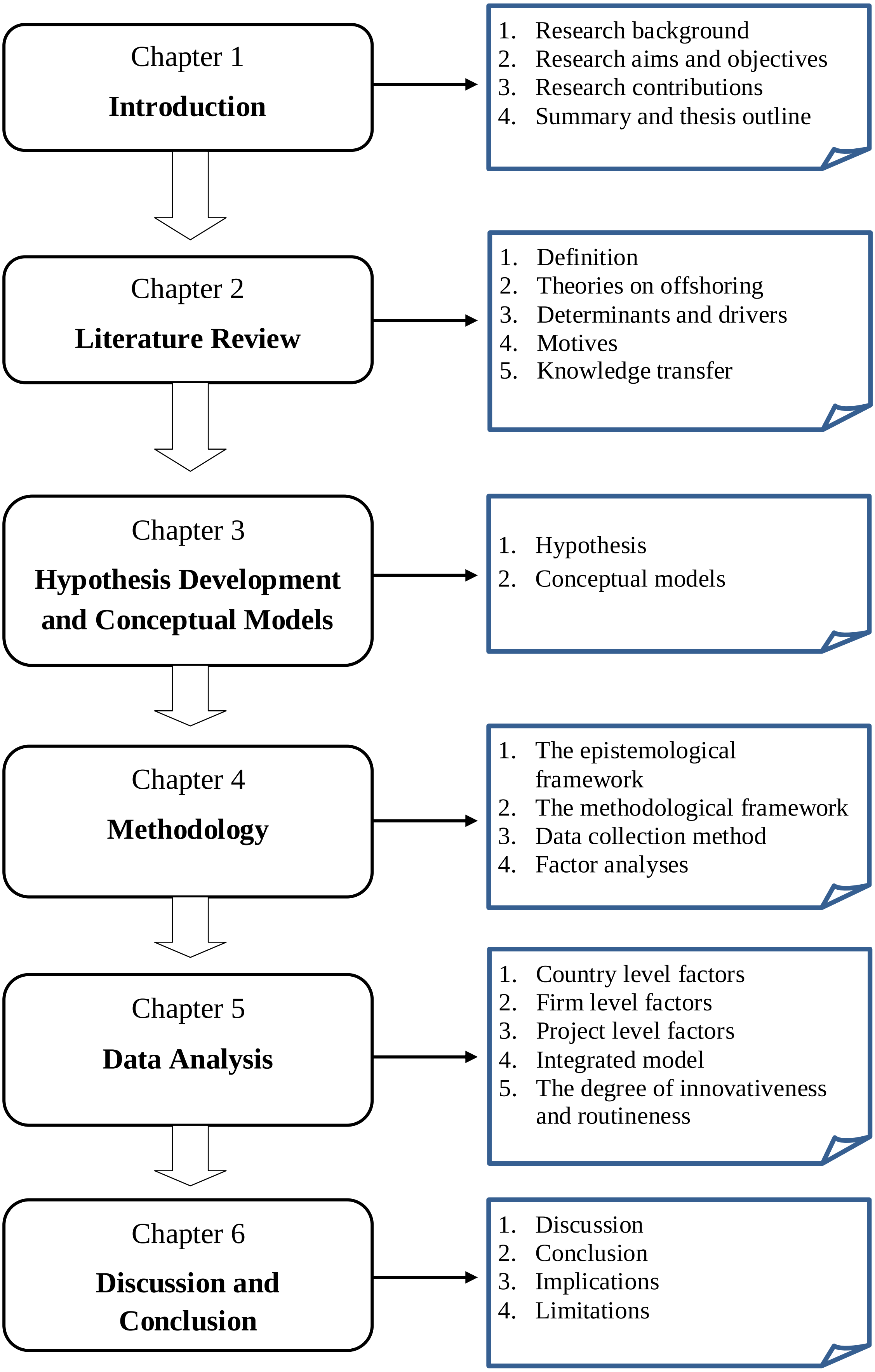


Figure 1: Outline of the Thesis

CHAPTER 2 – LITERATURE REVIEW

Research on offshoring can be found in the three literature streams: international business literature related with localization aspects, strategic management literature investigating core competencies, competitive advantage and firm boundaries and supply chain management literature examining aspects of logistics and distribution (Maskell et al., 2007). Based on studies done in these three research streams, the chapter starts with the definitions of R&D, internationalization, outsourcing and offshoring, and continues with the theories used in offshoring. Furthermore, the broad review of literature on R&D offshoring will also be investigated.

Defining R&D and offshoring

Despite the loose definition of offshoring in the popular press as the "relocation of business processes to take advantage of a supply of skilled but relatively cheap labour" (Mudambi and Venzin, 2010, p.1510), in the academic literature offshoring is generally understood as "a strategy of transferring activities that had previously been performed in the home country across national borders" (Rilla & Squicciarini, 2011). According to OECD (2007), "offshoring is the location or transfer of activities abroad and this includes transfer of activities within the MNC network as well as to third parties". Moreover, Manning et al. (2008) define offshoring "as a process where the business functions supporting home-based and worldwide operations are sourced from a location outside the home country". Also, Jensen and Pedersen (2011) determine that "offshoring is the disaggregation, relocation, and reintegration of activities and business processes across borders". Furthermore, Lewin et al.

(2009) give the definition of offshoring “as a process of sourcing and coordinating tasks and business functions across national borders”. Similarly, Doh et al. (2009) define offshoring “as the transnational relocation or dispersion of activities”. The common point of all definitions is that authors emphasize the geographical aspect of offshoring by highlighting that it is transfer or relocation of activities, tasks or processes across national borders. Even though the transferring of activities across national borders is an important dimension of offshoring, the final destination of transfer is also another aspect which is as important as the former. The final destination of activity transfer can be either a neighbouring country or a country from another continent. And based on geographical distance between the home and host countries offshoring is classified into ‘nearshore’ and ‘offshore’. According to Chakrabarthy (2006), “nearshore” and “offshore” are close, but different concepts. He defines “nearshore” countries as countries that are neighbors of the home country, while countries which are geographically far away can be considered as “offshore” countries. Hahn et al. (2011) develop this concept by defining ‘nearshoring’ “as the transfer of activities from home country to a geographically close host country which has a strong economic integration agreement or common economic zone with the home country”; while ‘offshoring’ is defined as the “transfer of activities from home country to a geographically distant host country or to one without a strong economic integration agreement or common economic zone with the home country”. Erber and Ahmed (2005) exemplify ‘nearshoring’ by mentioning major nearshoring destinations for US MNCs such as Mexico and Canada, while Ireland and Eastern Europe are nearshoring sites for European MNCs. However, Chakrabarthy (2006) also emphasizes that ‘nearshoring’ is a new, unexamined research area in international business; as a result, in the literature the term “offshoring” is often used to broadly imply “nearshoring” too.

A distinction also can be made on the basis of the ownership of relocated activity. Captive offshoring is “a type of offshoring where offshored activities are fully or partially conducted by vertically integrated affiliates or by acquired firms located in an offshore market, and this type of offshoring is seen mainly as a way for companies to enter a country” (Rilla & Squicciarini, 2011), while offshore outsourcing refers to “activities conducted by non-integrated suppliers located in an offshore market” (Jahns, Hartmann, & Bals, 2006; Maskell et al., 2007). Whereas captive offshoring and offshore outsourcing are the most known types of offshoring, there is a new type of offshoring entitled ‘joint venture offshoring’, where companies establish a joint venture with the offshore vendor.

One of the hotly debated discussions in international business is which relocated activities should be accepted as offshoring processes. Lewin et al. (2009) argue that offshoring operations should be differentiated from support operations. According to Lewin et al. (2009), all activities carried out to support global or domestic operations can be accepted as offshoring activities, while activities supporting local operations are not. Based on this concept, a HR or IT department in a foreign subsidiary to support local operation cannot be considered offshoring— although HR or IT services relocated to offshore locations in support of global or home-based HR or IT functions would be accepted as offshoring (Lewin et al., 2009).

It was mentioned before that the focus of this study is offshoring of R&D. Since the offshoring process was defined above, the next concept which should be defined is R&D. According to OECD (2002), R&D refers to the creative work undertaken to increase the stock of knowledge and three types of R&D can be differentiated: i) *basic research* is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view; ii) *applied research* is also original investigation undertaken in order to acquire new knowledge, however, it is directed primarily towards a specific practical aim or objective; and iii) *experimental development* is systematic work, drawing on existing knowledge gained from research and/or practical experience, that is directed to producing new materials, products or devices, installing new processes, systems and services, or improving substantially those already produced or installed. Khurana (2006) and Li and Kozhikode (2009) develop the standard OECD typology of R&D and distinguish four types of experimental development: *new product development*; *product adaptation and extension*; *product support engineering*; and *process engineering*. Maskell et al. (2007) argue that R&D belongs to the upper end of value-added activities, which are considered as strategically important and knowledge intensive activities, so for most of the firms R&D activity is core activity which gives them competitive advantage. Moreover, Di Gregorio et al. (2009) mention that R&D has some characteristics usually related to services, called intangibility, perishability and heterogeneity, which make it highly tacit, and the knowledge it creates difficult to transfer and absorb.

It can be said that in the context of international business, 'internationalization of R&D', 'offshoring of R&D' and 'outsourcing of R&D' are often interchangeably mentioned concepts, so there is usually no elaboration on the differences between them. However, these three terms refer to three different, but related processes. While Lewin et al. (2009) determine offshoring "as a new form of internationalization by which firms disaggregate their value chain of core activities across multiple locations, to include the option of potentially externalizing specific processes and capabilities to third-party providers", Jahns et al. (2006) view offshoring 'as a new term in outsourcing to very remote locations". To draw the precise borders of offshoring of R&D, first of all, internationalization and outsourcing concepts should be defined.

Internationalization has been widely used to describe the outward movement in a firm's international operations (Hakanson & Nobel, 1993). Others have defined it "as the process of increasing involvement in international operations" (Granstrand, 1999). Both definitions imply that internationalization is associated with increasing investment in foreign markets. Nevertheless, based on various factors, a firm can drop a product, divest a division, sell a foreign production plant, or lay off people involved in their international operation. In other words, internationalization can also take the form of de-investment. Therefore, the literature defines internationalization "as a process through which a firm increases its level of involvement in foreign markets over time" (Granstrand, 1999), and "traditionally considered it as a series of events that take place over time" (Granstrand et al., 1993), also "as a process of adapting firms' operations (strategy, structure, resource) to international environments". From these definitions it can be concluded that internationalization includes all operational activities of a firm taking place beyond national borders, while offshoring is one of the small parts of it. Whereas internationalization and offshoring are strategies of the firm related to geography, outsourcing is related to the organizational strategy of the firm. According to Hatonen and Eriksson (2009), "outsourcing is the transfer of activities and processes previously conducted internally to an external party". Similarly, Bunyaratavej et al. (2011) define outsourcing "as a process when a firm purchases products or services from another domestic or offshore company".

With internationalization, outsourcing and offshoring concepts now defined, I can give a clear definition of R&D offshoring and draw the explicit border of it. Internationalization of R&D covers a number of activities that are substantially different from each other. According to Brockhoff (1998), internationalization of R&D includes activities such as employment of foreign R&D personnel in strictly national, possibly headquartered-based organizations; importing some new technological knowledge from a foreign country, for instance buying patents or licenses; engagement in cooperative R&D with partners located in a foreign country and involving some transfer of resources into a foreign country; and establishing a unit which performs some type of R&D work in a foreign country, where all projects under its supervision are exclusively performed within this unit. Offshoring of R&D is a process related only with the transfer of R&D activity, tasks or projects across national borders. The offshoring and outsourcing of R&D can be distinguished based on the strategy of the firm, with the former related to geographical boundaries and the latter related to firm boundaries.

Analyzing the aspects of the R&D offshoring process discussed above, I define that *offshoring of R&D is the transfer, relocation or dispersion of R&D activities, tasks or projects supporting home-based and worldwide operations, which were previously located at home, to other countries, regardless of the specific contractual agreement and of whether the countries involved are geographically near or distant or have a strong economic integration agreement or common economic zone with the home country.* Typical R&D offshoring is shown in figure 2.

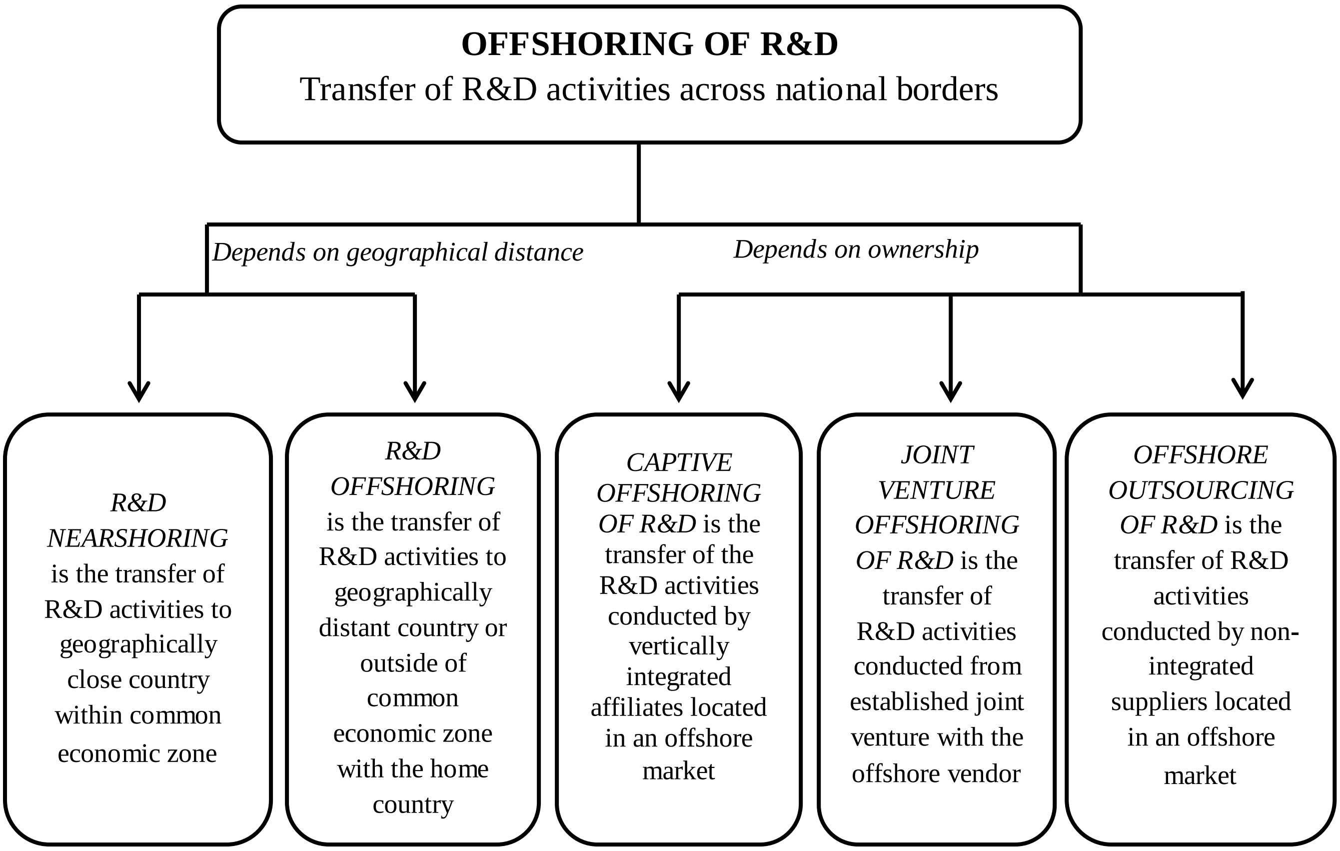


Figure 2. *Typifying R&D offshoring*

Source: Author's own compilation based on Lewin et al. (2009), Rilla and Squicciarini (2011), and Bunyaratavej et al. (2011)

Theories in offshoring

As it was discussed in the previous section, offshoring can be divided into three types, depending on ownership of activity: captive offshoring, joint venture offshoring and offshore outsourcing. Captive offshoring involves strategic, economic and geographical aspects. For joint venture offshoring, together with the aspects mentioned before, organizational structure and relationship with partner firm become important. Since offshore outsourcing is one of the types of outsourcing, the theoretical perspectives applied for outsourcing also can be applied to offshore outsourcing. Dibbern et al. (2004) argue that there are three types of theoretical perspectives or theories adapted for offshoring: *strategic theories* focused on how firms develop and implement strategies to achieve a chosen performance such as *resource-based* *view*, *game theory* and *strategic management theories*; *economic theories* such as *transaction cost theory, eclectic paradigm* and *agency theory,* focused on the coordination and governance of economic agents regarding their transactions with one another; and *social/organizational theories* like *a social exchange theory, innovation theories* or *relationship theories,* which concentrate on the relationships that exist between individuals, groups and organizations. Moreover, Hatonen and Eriksson (2009) claim that theory relating to offshoring could explain the organization of economic activities not only externally but also in a foreign location and mention geographical-location theory, which could be a perspective solution. Analyzing the theories and theoretical perspectives of studies on offshoring it was discovered that most theoretical frameworks are based on three main theories: the transaction cost economics (TCE), the resource-based view (RBV) and the eclectic (OLI) paradigm. In this section the characteristics and attributes of these theories will be examined and aspects of the theories based on which offshoring process is analyzed will be discussed. And at the end of the section a clear explanation of which theory or which aspects of theories will be used in the theoretical framework of this study will be given.

Transaction cost economics

Transaction cost economics or Transaction cost theory, established by Coase (1937) has been traditionally concerned with outsourcing, or the make or buy decision (Williamson, 1979). Furthermore, TCE has been applied to offshoring recently (Ellram, Tate, & Billington, 2008; Jahns et al., 2006; Madhok, 2002). It has received attention in the offshoring and outsourcing literature since it explains why some activities are retained at home while others are offshored. TCE was set out by Coase (1937), however, the main framework of the theory was developed by Williamson (1979, 1981, 1985). According to TCE, not only are production costs compromised – the cost of capital, labour, and materials – but also transaction costs.

The transaction cost is a cost incurred in making an economic exchange or the cost of participating in a market and is differentiated into ex-ante (information collecting costs, identification of supplier, the cost of negotiations and other costs arising prior to the contract) and ex-post (the cost of monitoring and control of the supplier arising after the agreement) transaction costs (Williamson, 1981). The focus of the theory is particularly on costs and efficiency rather than revenue. TCE begins with the assumption that markets are competitive and that market pressures minimize the need for monitoring and enforcing supplier behaviour (Williamson, 1981). Other assumptions are bounded rationality and opportunism (McIvor, 2009). Bounded rationality is the idea that in decision-making, the rationality of individuals is limited by the information they have, the cognitive limitations of their minds, and the finite amount of time they have to make a decision, while opportunism refers to decision makers acting with cunning.

Some authors argue that when transaction costs of market exchange are greater than the benefits of offshoring, then keeping the activities at home is preferred (Brouthers, 2002; Hennart, 1989). However, this conclusion takes into account only part of the theory, because in practice transaction costs are often difficult to assess. Because of this, Williamson avoids direct measurement of transaction costs themselves, instead focusing on other variables, like an asset specificity, uncertainty or frequency. As a result, the status of offshoring of activities may vary depending on these variables (Williamson, 1979).

Asset specificity refers to the level of customization associated with the transaction. Highly asset specific investments indicate costs that have little or no value outside the transaction; also highly specific assets cannot be used in another application or transferred to another customer (Klein, Crawford, & Alchian, 1978; Williamson, 1979, 1981). The costs related to asset specificity can be divided into three groups: i) physical asset specificity (product or service customization level), ii) human asset specificity (level of specialized knowledge involved in the transaction), and iii) site specificity (location) (McIvor, 2009). Moreover, asset specificity can have three different characteristics: non-specificity (highly standardized), idiosyncratic (highly customized to the organization) or mixed (incorporating standardized and customized elements in the transaction) (McIvor, 2009; Williamson, 1981). Asset specific activities can cause a problem in the case of offshore outsourcing, since the firm could be highly dependent on the supplying firm, and the supplying firm could then become opportunistic, raising prices, reducing service levels, or other such cases. When the supplying firm owns the specific assets, it is subjected to potentially significant risk associated with accepting the activity (Ellram et al., 2008; Klein et al., 1978). As a result transaction cost theory predicts that the higher the level of asset specific investment required, the less likely the activity is to be offshored (Riordan & Williamson, 1985; Williamson, 1981).

Uncertainty in TCE was divided into two: (i) uncertainty in the external environment that comes from the marketplace, and (ii) the internal uncertainty that comes from the firm itself (Williamson, 1985). External uncertainty is related to the degree of volatility and the unpredictability in the market place with regard to changes in technology, availability, key players, price, and other significant disruptions to the market. In this case TCE supposes that in highly uncertain markets, companies prefer to perform an activity at home, believing that they can favourably respond to the whims of the market more readily than their supplying firms (Ellram et al., 2008). Sometimes internal uncertainty deals with the case where the firms do not know exactly what they want or there is ‘uncertainty in requirements’ as it is called in the literature, and they are not able to verify whether a supplier has performed as promised (Amaral, Billington, & Tsay, 2006). If the firm has an activity with uncertain requirements, the firm may choose to keep that activity in house because of controlling the unanticipated benefits and costs. On the other hand, if the firm offshores that activity it may limit its options or flexibility. Offshoring requires the firm to specify what is and is not part of the contract and to accurately define levels of service. There is a risk of being wrong, not getting what was required and of limiting its future alternatives. In this kind of case, TCE predicts that the firm will keep the activity at home (Amaral et al., 2006; Williamson, 1985). Uncertainty regarding performance of the contract also can exist if the nature of the transaction is such that the contracting parties have no assurance that the other party has actually fulfilled its obligation and performed as specified. In these situations, the firm may be paying for something and not actually getting what it paid for. In such a situation TCE posits that the firm prefers to perform the activity at home, rather than offshore it (Ellram et al., 2008; Williamson, 1985).

Transaction frequency is related to how frequently the transaction takes place and the number of transactions, whereby the number of transactions is representative of the total cost of transactions; more transactions means higher cost. Accordingly, TCE proposes that offshoring becomes cost prohibitive as the number of transactions increases (Williamson, 1985).

Even though many authors (Agarwal & Ramaswami, 1992; Ellram et al., 2008; Erramilli & Rao, 1993; Jurison, 1995; Lacity & Hirschheim, 1993; Lacity & Willcocks, 1995; Makino & Neupert, 2000; Tate, Ellram, Bals, & Hartmann, 2009) have suggested that TCE provides a potentially useful framework for explaining the offshoring and outsourcing process, some writers (Dosi & Marengo, 1999; Ghoshal & Moran, 1996; Kogut & Zander, 1993; Langlois, 1992) within strategic management fiercely criticize the transaction cost theory. The critique is related to the reliance on opportunism and the neglection of dynamics and differential capabilities in TCE. “Knowledge-based academicians” (Hodgson, 1998; Lacity & Willcocks, 1995) often argue that because of differential capabilities different production costs arise, and that such cost differentials may crucially affect the outsourcing and offshoring decision. Therefore, companies may internalise activities because they can carry out these activities in a more production cost efficient way than other companies are capable of. Some authors argue that the existence of the company can be explained in knowledge-based terms and without making use of the assumption of opportunism (Hodgson, 1998; Kogut & Zander, 1993). According to Prahalad and Hamel (1990), transaction cost theory is incapable of recognizing the need for the company to focus on its core competences and to conserve its strategic resources, since it does not study the capabilities of the organization or its potential partners or suppliers when outsourcing or offshoring decisions are analyzed.

To summarize, TCE is one of the most influential approaches in management, and because of that many studies use the framework of TCE to develop an understanding of how firms are offshoring and outsourcing their activities. TCE postulates that firms will choose the business alternatives that yield the lowest total cost of running their operations. Transaction cost theory also hypothesizes that firms will not offshore to areas where high potential risk of supplier opportunism exists. According to theory, the highest level of supplier opportunism occurs when the buying company cannot specify or does not know what it wants, and when the buying company cannot accurately assess whether the supplier is actually keeping its commitment. However, even TCE cannot fully explain the complexities of the offshoring process, especially the internal resource, capability and location aspects. To understand these aspects some authors use different theories such as resource based view or eclectic paradigm.

Resource-based view

The second theory, resource-based view is popular in the strategic management literature. According to this theory, the firm is “a unique bundle of assets and resources that, if employed in distinctive ways, can create competitive advantage” (Barney, 1991). These resources are divided into three types: i) physical resources, ii) human resources and iii) organizational resources (Conner, 1991; Conner & Prahalad, 1996). According to Barney (1991), there are four criteria: value, rarity, imitability and organization that must be met so that a resource with potential can create competitive advantage. Resources are accepted as valuable if they allow a firm to exploit opportunities and resist threats in the business environment. The resource is considered rare if only a small number of firms possess it. If the resource is not rare, then it is unlikely to be a source of competitive advantage. The imitability criterion is related to how easily the rival firms can replicate a valuable and rare resource possessed by a company. In effect, this analysis determines the sustainability of the competitive advantage in the resource. Barney (1991) argues that a company must be organized so it can exploit its resources and capabilities with maximum efficiency. Reporting structure, management control systems and compensation policies construct the main framework of the organization criterion. In essence, the resource-based view suggests that competitive advantage is not a function of just opportunities in the external environment, but also a function of which resources the firm can identify, develop, deploy and protect (Barney, 1991; Penrose, 1959; Wernerfelt, 1989).

The important point of the resource-based view in interpreting the outsourcing and offshoring processes is that it could explain why organizational activities relative to competitors are performed internally (Grant, 1991). However, how a firm develops its capabilities and how the developed capabilities affect competitive position and performance is a major concern of the resource based view (Barney, 1991; Barney, 2001; Grant, 1996). According to Langlois and Robertson (1995), the company boundaries can be designated by comparing internal capabilities with the capabilities of rival firms. Thus, the outsourcing or offshoring decision is affected by the ability of the firm to invest in developing a capability and sustaining a superior performance position in the capability relative to rival firms. RBV proposes that, if the firm lacks the necessary resources or capabilities to operate the activity at home, it can be offshored. Also theory suggests that the firm does not necessarily have to depend on internal resources but can also acquire complementary resources from outside geographic and organizational boundaries (Argyres, 1996b).

However, resource based view theory has a number of methodological and practical difficulties that restrict the generation and testing of direct hypotheses (Priem & Butler, 2001a). To test the hypothesis of RBV, the identification and measurement of relevant resources are required. Since the majority of the resources are associated with organizational learning and are commonly unobservable, the measurement of these resources is often problematic (Priem & Butler, 2001b). Furthermore, most of the researchers use an extremely varied set of proxies for key capabilities and resources, which makes systematic comparison across the empirical literature more difficult than at the beginning of the research (Lockett, Thompson, & Morgenstern, 2009).

Thus far, the literature has referred to TCE and RBV as independent approaches to the outsourcing and offshoring decisions. While transaction cost theory focuses primarily on the role of efficient governance in explaining firms as institutions for organizing economic activity, the focus of the resource based view is on the search for competitive advantage, through resource analyses (Ellram et al., 2008). Nevertheless, there is a growing body of international business literature arguing that neither theoretical perspective can fully explain the phenomenon of R&D offshoring (Madhok, 2002; Madhok & Phene, 2001). So, to fully comprehend the process of R&D offshoring, TCE and RBV perspectives shall be combined, or another theory which includes important aspects of both be used. One of the theories which can be helpful for this is the eclectic paradigm or OLI model.

The eclectic paradigm

The eclectic paradigm is a theory in economics developed by Dunning (1979; 1980, 1988) and is also known as the OLI-Model or OLI-Framework. It is a further development of the theory of internalization, which is based on the transaction cost theory. It also combines theories of organizations and geographical-location theory and all relate to various types of activities and explore the interaction between them, and between ownership, locational and internalization factors (Bunyaratavej et al., 2007).

Dunning (1979) argues that companies will involve in foreign direct investment (FDI) if three conditions are satisfied. First, companies must possess ownership advantages, specific and intangible assets, over other firms to offset the disadvantages of not being a local firm. Secondly, companies must decide how to profit from exploiting those advantages in a foreign country which offers certain locational advantages such as production factors, cheap or skilled labour, natural resources or infrastructure. Thirdly, companies must decide whether they will pursue these activities internally or through an external provider (Dunning, 1980).

The O in the OLI model stands for the company's ownership advantages. According to Dunning (1979) two types of competitive advantage can be recognized. The first is linked to the ownership of a particular unique intangible asset. The second competitive advantage is related to the ownership of a complementary asset (Bunyaratavej et al., 2007). The L stands for the location factors that influence firms' activities when moving an operation abroad (Cantwell & Narula, 2001). These conditions can relate to the presence of the location advantages a country can offer, such as market potential – which can lead to scale economies – and contemporary factors such as efficient infrastructure and government policies (Cantwell & Narula, 2001). The I represents internalization advantages. Several reasons for internalization have been identified, though it should be borne in mind that they can vary between industries. A primary reason for internalization is market failures, which can broadly be divided into three groups: those that arise from risk and uncertainty, those that stem from the ability of firms to exploit the economies of large-scale production – but only in an imperfect market situation, and where a transaction generates costs of products and benefits external to that transaction (Dunning, 1988).

Madhok and Phene (2001) question the relevance of the OLI paradigm within the contemporary business environment. They criticize the theory for being an efficiency argument, and stress that the decision to internalize is no longer considered on grounds of efficiency. They further argue that the OLI model is not adequately equipped to deal with the question of performance differences across firms. Also, they state that the ownership advantages are no longer solely rooted in the home country, since it is increasingly recognized that the ownership advantages could be more dispersed and located at different sites.

In this thesis, offshoring of R&D will be examined through the TCE, RBV and Eclectic paradigm lenses. However, the main framework of my research will be based on Dunning's Eclectic paradigm. Eclectic paradigm can be useful for analyzing the offshoring of R&D activities of multinationals by interpreting ownership, internalization and location advantages in the context of R&D, with these advantages being related mainly to the technological routines and trajectories of the firms and the host countries.

Determinants and drivers of offshoring

In the last two decades, the study of offshoring has gained considerable attention from both mainstream media as well as the academic community. Recent discussions suggest that firms are now increasingly transferring activities across geographical boundaries. Offshoring is no longer limited to peripheral and low value added activities as firms are now relocating their high value added activities that were traditionally retained at home. This section will provide a systematic review of the prior literature on offshoring of activities. The literature review will serve as the basis for the arguments and hypotheses developed in later chapters. The literature on offshoring can broadly be divided into three streams of research. The first and main set of studies on offshoring examines the drivers, determinants and location choice of the offshoring process (Argyres, 1996a; Demirbag & Glaister, 2010; Doh et al., 2009; Hahn et al., 2011; Quinn & Hilmer, 1994). The second related research stream focuses on the entry mode decisions made by firms (Contractor & Mudambi, 2008b; Doh, 2005; Mudambi, 2008). The last group of studies looks at the impact of offshoring on firm performance and knowledge transfer (Gilley & Rasheed, 2000; Pedersen et al., 2003).

There have been three stages in the offshoring process since 1960. The first stage of offshoring, which mainly related to manufacturing operations, was characterised by the geographically clustered spread of production activities (Hatonen & Eriksson, 2009). In the second stage, the various production stages were split up, a wider range of value chain activities was offshored, and firms started to offshore labor-intensive tasks such as IT and customer services (Rilla & Squicciarini, 2011). The third and current stage involves offshoring of knowledge-intensive activities such as R&D, with offshoring increasingly involving firms' core competences, and affecting even larger parts of firms' value chains (Lewin & Peeters, 2006). Based on these stages offshoring can be classified into three types:

offshoring of production, offshoring of labour-intensive activities and offshoring of knowledge-intensive activities. The last two types of offshoring have a common point; these activities are service activities, and the only difference is the former includes labour-intensive or low-value activities, while the latter consist of knowledge-intensive or high-value activities. In the literature most of the research done on offshoring has focused on offshoring of production. It is understandable, since offshoring of production is the most common type of offshoring and it was also the first stage. However, the recent studies on offshoring such as Bunyaratavej et al. (2011); Bunyaratavej et al. (2007); Bunyaratavej, Hahn, and Doh (2008); Doh et al. (2009); Hahn and Bunyaratavej (2010); Hahn et al. (2011); Hahn, Doh, and Bunyaratavej (2009a) examine the offshoring of services, but without distinguishing between the low-value and high-value activities. They argue that the offshoring of production and offshoring of services are totally different cases with different drivers, location determinants, risks and different objectives. Furthermore, research by Jensen and Pedersen (2010) analysed the offshoring process by differentiating low-value and high-value activities. However, they did not separate offshoring into production and services. The comprehensive research done on offshoring till now is the survey conducted by Offshoring Research Network (ORN). The Offshoring Research Network project investigates a wide range of business functions and processes, such as information technology (IT), finance and accounting, contact centres, human resources, legal services, analytical and knowledge services, software development, procurement, marketing and sales, engineering and new product development. The research does not examine offshoring of manufacturing activities, nor does it capture outsourcing or offshored or outsourced shared services activities. The studies based on this survey investigate drivers, motives and locational determinants of offshoring (Lewin, Couto, & Hamilton, 2007; Lewin et al., 2009; Lewin & Volberda, 2011; Manning et al., 2008; Massini, Perm-Ajchariyawong, & Lewin, 2010), governance modes of firms (Lewin & Peeters, 2006;

Peeters, 2009; Roza, Van den Bosch, & Volberda, 2011), mechanisms of firm decisions (Lewin & Volberda, 2011), and knowledge service clusters (Manning et al., 2008; Manning, Ricart, Rique, & Lewin, 2010). The literature shows that research focusing only on offshoring of R&D is very limited. As described above, some studies examine offshoring of R&D within offshoring of services (Bunyaratavej et al., 2011), while others analyse within offshoring of high value activities (Contractor et al., 2010; Jensen & Pedersen, 2010). Moreover, some studies investigate R&D offshoring based on offshored R&D projects (Demirbag & Glaister, 2010; Hahn et al., 2011; UNCTAD, 2005). Furthermore, some authors are confused between offshoring of R&D and internationalization of R&D, and accept drivers and determinants of R&D internationalization as the drivers of R&D offshoring (Ambos & Ambos, 2011).

Although offshoring of R&D is one of the types of offshoring, it should not be forgotten that it is also a new form of internationalization of R&D (Manning et al., 2008). So, in order to understand the phenomenon of R&D offshoring, it will be beneficial to review some aspects of R&D internationalization. As in the case of offshoring, most of the authors assume the internationalization of R&D began in the 1960s (Manning et al., 2008). However, the studies of Granstrand (1999; 1993) and Cantwell (1995) claim that the starting point of R&D internationalization is long before then. Granstrand (1999) argues that the history of internationalization of R&D goes back to the 1880s, when the Swedish scientist and entrepreneur Alfred Nobel founded Nobel Dynamite Trust Company, while Cantwell (1995) found that in the 1920s and the beginning of the 1930s the largest Multinational Corporations (MNCs) carried out about 7 per cent of their total R&D at locations abroad. Nonetheless, there are not enough studies on internationalization of R&D before the 1960s, so it is accepted that the beginning of these processes is the 1960s.

Over the past five decades, both the extent to which firms perform R&D outside their home countries and the types of R&D has changed considerably. During earlier periods of R&D internationalization (the 1960s and 1970s) MNCs established R&D centres close to manufacturing facilities in order to support foreign subsidiaries with complementary design and development capabilities (Granstrand et al., 1993). In later phases MNCs (the 1980s and 1990s) began to shift their main focus from exploitation of home-developed technologies to explore and develop new technologies overseas. So, analysing this historical evolution of the R&D internationalization process, it can be distinguished by two periods: from the 1960s to 1970s, and from the 1980s to the present. Even though Reddy (1997) claims that this process can be divided into four periods or as he defined into four waves (1960s, 1970s, 1980s and 1990s), based on types of R&D transferred abroad, he agrees with the general consensus that in the first two waves of R&D internationalization firms transfer R&D to adapt it or develop new products for the local market; whereas in the last two waves firms transfer R&D to produce products for regional or global markets. He also declares that in the last period access to qualified personnel and tapping into the host's innovation infrastructure is important. Similarly, Kuemmerle (1999) classifies the history of internationalization of R&D into two periods, based on the strategy of the firms. The first period, when the "home-base exploiting R&D" (Kuemmerle, 1999) or "asset-exploiting R&D" (Dunning & Narula, 1995) strategy was dominant, took place between the 1960s and 1970s. The aim of the home-base exploiting strategy was to use the existing firm-specific capabilities in foreign environments to increase firm value. The second period emerged in the 1980s and continues today, and the dominant strategy of the firms in this period is "home-base augmenting R&D" (Kuemmerle, 1999) or "asset-augmenting R&D" (Dunning & Narula, 1995). In this case, in order to augment a firm's existing stock of knowledge, firms monitor technological advantages residing in the host country and transfer that knowledge to the headquarters in the home country. The main aim of this strategy is to strengthen the core competencies or strategic positioning of the investing firms (Florida, 1997). From the perspective of offshoring, it can be argued that the first period of R&D internationalization, where firms adapt a home-base exploiting strategy, cannot be accepted as offshoring of R&D, since the thesis defines offshoring of R&D to be the transfer of activities supporting home-based and worldwide operations, but not local. Some studies (Ambos & Ambos, 2011) analyse or examine offshoring of R&D based on the research done on internationalization of R&D. Some aspects of R&D internationalization, especially the findings from the studies on the last period of the process, when firms apply a home-base exploiting strategy, can be applied to R&D offshoring. However, the findings from the research done on local supporting R&D internationalization is not suitable for analysing R&D offshoring, since these processes have different motives, drivers and determinants.

The literature investigating R&D offshoring is relatively small, and most of this literature largely concentrates on information technology services, since the offshoring of IT-related functions has hugely increased the offshoring of skilled tasks. However, there are some review articles on offshoring of R&D, which cover economic, political and managerial aspects of this process (see, for example, Hatonen and Eriksson (2009), Dibbern et al. (2004), Lacity, Khan, and Willcocks (2009) and Rilla and Squicciarini (2011)). Some of these articles (Dibbern et al., 2004; Hatonen & Eriksson, 2009) use the framework consisting of questions 'why', what', 'where' and 'how' to analyse all aspects of R&D offshoring. These studies investigate 'why firms offshore', 'what type of service can be transferred abroad?', 'where to offshore' and 'how should these services be offshored so that they will be successful?' Even though these studies can be accepted as successful reviews on offshoring of R&D, since they give a deep understanding of the offshoring process, the main focus of these studies is the outsourcing process rather than offshoring. Moreover, the determinants of 'why firms offshore R&D activities' can be distinguished into 'push' factors caused by home factors such as high wages, scarcity of talent pool and 'pull' factors related to country or location specific factors like low wages, large pool of qualified personnel and government incentives. It is interesting that most of the pull factors are also used when studies examine where firms offshore R&D. Sometimes, pull factors are also called location specific factors, and it seems as though the questions 'why firms offshore' and 'where to offshore' overlap each other. The recent study of Rilla and Squicciarini (2011) is also one of the excellent reviews on offshoring of R&D. However, their focus is on offshore outsourcing and only marginally on captive offshoring. Even though there is small and limited literature on R&D offshoring, most of the studies emphasize that the main determinant of this process is cost reduction through offshoring of activities to low cost countries.

Cost Saving

Cost saving certainly remains an important factor for offshoring, especially for basic, routine activities. In the international business literature, offshoring annual surveys done between 2004 and 2006 indicated that labour and the other cost saving factors were consistently evaluated as the key strategic drivers of offshoring (Bunyaratavej et al., 2007). For instance, Farrell (2005a) claims that American firms save $0.58 for every dollar spent on projects they transfer to India. Also, German firms save €0.52 for every euro spent on projects offshored to India. Recent research done by Duke University CIBER and Consulting (2005) stated that the primary reason for offshoring is the cost reduction (Manning et al., 2008). According to a survey by Deloitte and Touche (2007), most of the financial institutions surveyed save more than 40 per cent for each business process offshored. The first cost saving opportunity is in labour. The wage differences between developed and developing nations are so large that they invariably offset any extra capital investments or management costs required to relocate activities. US firms can typically cut their total costs by 45% to 55% by offshoring their activities to India (Farrell, 2004). Even though some studies (Bunyaratavej et al., 2007; Lewin et al., 2009; Manning et al., 2008) claim that the major part of cost saving comes from the difference in wages between developed and developing countries, Jensen and Pedersen (2011) argue that not only wage difference between developed and developing countries is largest share in cost saving, but also infrastructure, tax and regulatory costs in developing countries are significantly lower than in developed countries, which results in huge cost saving for firms. For companies which are offshoring the activities to foreign affiliates, the consolidation of activities in fewer locations and the economies of scale are also effective factors decreasing the cost as well as wage difference between developed and emerging countries (Doh, 2005; Farrell, 2005a). Lahiri and Kedia (2011) support this view and mention that cost reduction emanates from three sources: provider's labor wage differentials, economies of scale and business specialization. Furthermore, Farrell (2005a) detects that some US firms offshoring to India use low-cost local labor to develop their own software instead of purchasing more expensive branded products from the global software corporations. Whereas taking the license of more complicated software costs millions of dollars, these firms pay only several thousand dollars to develop their own software program. In addition, some companies use hire employees for jobs that could be done automatically by machine. At home these companies use expensive software or machines to operate a task, while by offshoring these tasks companies could use low cost workers instead of software or machines, which also can be accepted as a type of cost saving (Farrell, 2005a).

Researchers have long argued that when firms enter foreign markets, they face additional costs associated with doing business in unfamiliar environments where local competitors have both tangible and intangible advantages (Dunning, 1980). These costs involve expenditure associated with acquiring information regarding cultural, political and economic difference (Dunning, 1980). Costs may also result because foreign firms sometimes receive discriminatory treatment from host country governments, buyers, and suppliers in comparison to local firms (Bunyaratavej et al., 2007). So, in the case of offshoring, cost savings may be lower than expected and sometimes higher costs associated with doing business abroad can offset the cost saving from offshoring. Moreover, Stringfellow et al. (2008) argue that offshoring entails invisible or hidden costs that only become visible when firms start to manage and operate their global offshoring activities. Also, it should not be forgotten that rapid wage inflation in popular offshoring locations is one of the most important problems. For example, in 2006 wages in India grew by 22% from the year before, shattering a previous trend of 12% annual inflation in wages (Hahn et al., 2011).

While cost is still accepted as an important determinant of offshoring, especially for basic, back office, and routine activities (Bunyaratavej et al., 2011), other studies imply that cost is only a subset of the factors that companies must take into consideration (Bunyaratavej et al., 2011). Moreover, some researchers have even proposed that a country is more likely to be a destination of R&D offshoring when the average wage of a country increases (Youngdahl & Ramaswamy, 2008) because of the importance of attracting high-skilled specialists. Furthermore, according to some studies offshoring of high value added activities can cause a long-term disadvantage despite short-term cost savings (Farrell et al., 2006). For some tasks or activities such as engineering, software development or R&D, high-skilled workers are required to perform high-quality work and wages may be a more secondary consideration (Hahn et al., 2011). Also it can be argued that quality is paramount in offshoring of R&D and high-quality skill sets are not easily transferable or duplicable, so low wages alone will not constitute a primary explanatory variable to explain long-term R&D offshoring location decisions (Bunyaratavej et al., 2007). In the literature some studies (Contractor & Mudambi, 2008a; Contractor et al., 2010; Demirbag & Glaister, 2010) demonstrate that wage rates alone have little explanatory significance in comparing countries as attractive locations. On this point academic literature divides into two streams: the first stream shares the popular perspective that the primary objective of offshoring is cost saving through the relocation of business processes to low wage locations (Mudambi, 2008), while another stream of literature views offshoring as a more general location strategy that incorporates cost saving and knowledge seeking (Demirbag & Glaister, 2010).

The majority of research indicates that the importance of cost saving as a determinant of offshoring tends to decrease as firms gain experience with offshoring and especially with offshoring of increasingly complex and advanced activities (Lewin et al., 2009). According to Jensen and Pedersen (2010), the cost saving determinant determines the initial decision to offshore but does not affect subsequent evolution towards offshoring of more advanced activities. Similarly, Bunyaratavej et al. (2007) detect that firms evolve from just cost saving to seeking for knowledge. Also, research done by Maskell et al. (2007) demonstrate that cost is not as important as the mass media might suggest, but that access to skilled and qualified workers is a substantial determinant of services offshoring among firms. Moreover, Dossani and Kenney (2003) found that though US firms were initially attracted to India for reduction of costs, they continued offshoring and expanding facilities because of the high quality of the personnel. So, it can be concluded that more high-value added activities are offshoring, so cost saving becomes less important.

Human Capital

For a growing number of firms, reducing labour costs is no longer the only strategic driver behind offshoring decisions. Accessing pools of highly skilled talent around the world has emerged as a new key driver (Bunyaratavej et al., 2007; Lewin et al., 2007; Lewin et al., 2009; Manning et al., 2008). This change is mostly caused by the trend that offshoring is no longer restricted by standardized information technology and business processes, but increasingly involves product development functions, such as R&D and product design (Maskell et al., 2007). Results from Duke University CIBER and Consulting (2005) survey indicate that between 2004 to 2006 access to human capital was the second most important offshoring determinant after reduction of costs, and that new product development projects – including engineering services, product design, and R&D – were the second most frequently offshored projects after information technology.

Manning et al. (2008) argue that there are two major drivers of the access to talent pool trend. The first driver is an increasing shortage of qualified engineering and science talent in the United States and Western Europe. The research by Athey (2004), Erken and Gilsing (2005b) and Lewin et al. (2009) show that the number of US and Western European citizens graduating with master of science and engineering, and PhD degrees has been stagnating or decreasing since the 1990s. Manning et al. (2008) claim that the reasons for this stagnation are non-attractiveness of science and engineering careers, insufficient level of training in maths and science in high-schools, and an aging population. Moreover, reduction in quota from 195,000 to 65,000 for H1B visa program, which allowed foreign S&E talent to work in the US, also caused a shortage of talent in the western world. The second major driver of access to the talent pool is the extensive pool of highly qualified talent in some developing countries such as India and China, which feature a growing young population, growing investment in improving higher education systems, and increasing domestic career opportunities (Manning et al., 2008). However, Jensen and Pedersen (2010) argue that the formal qualifications of a large proportion of science and engineering graduates in India, China and other emerging countries remain below European and US standards. According to McKinsey Global Institute, only 8-12% of S&E graduates from emerging countries meet the requirements of European and US companies (Farrell, 2006). Moreover, Farrell (2006) describes this ‘suitable’ talent as a university graduate with up to seven years of experience and who has the language skills, technical knowledge and the ability to interact successfully in a corporate environment.

In terms of conceptual work, Graf and Mudambi (2005) developed a framework that added the factor of human capital to Dunning’s eclectic paradigm. Furthermore, they identified five dimensions of the value of human capital for offshoring: availability, experience, quality, compensation level and cultural distance. The recent research of Contractor and Mudambi (2008a) improves this conceptual framework by looking to the human capital factor from a resource-based view and human capital theory perspective. Even though it is a very successful development of the eclectic paradigm and human capital theory, the measurement used in these studies is not suitable for implementing in the case of offshoring. It was mentioned before that there are some criteria for personnel to become talented. An important criterion is that personnel should have an advanced university degree like a master degree or PhD. Measurements based on the number of graduates having advanced university degrees would be more appropriate for offshoring, while the study of Contractor and Mudambi (2008) used average literacy rate of country population and total public spending on education. It is expainable, since the primary aim for that study is not offshoring.

Knowledge Infrastructure

The importance of knowledge infrastructure as a determinant factor for offshoring of R&D has been well established in the literature (Graf & Mudambi, 2005). It has already been mentioned that some studies (Demirbag & Glaister, 2010; Kedia & Lahiri, 2007; Lewin et al., 2009) claim cost saving and knowledge seeking strategies for R&D offshoring should be analysed together. In a recent study, Demirbag and Glaister (2010) identified that the R&D cost and knowledge infrastructure trade-off between country clusters has different levels of development and they highlight that even though R&D cost level is a significant driver of location choice, it should be interpreted in conjunction with the knowledge infrastructure parameter. Moreover, research by Shimizutani and Todo (2008) investigating the drivers of R&D offshoring by Japanese MNCs suggests that the stronger the host country knowledge infrastructure, the greater the possibility that the country will attract R&D offshoring.

One of the important components of knowledge infrastructure that influences R&D offshoring is the existence of a well-developed and implementable intellectual property right (IPR) system in the host country (Kshetri, 2007). The results of a survey done by UNCTAD (2005) support the argument that IPR is a significant determinant of R&D offshoring and that IPR develops the environment for innovative R&D activities. Moreover, Rilla and Squicciarini (2011) argue that countries with strong IPR protection have a significant advantage in terms of attracting R&D offshoring.

According to Liu, Feils, and Scholnick (2011), the quality of institutions in the knowledge infrastructure of the host country influences attracting the R&D offshoring. Better legal institutions tend to provide the enforcement of contracts, support greater transparency in the business environment, and decrease uncertainty about legal rights. Also, the better the quality of the institutional environment, the lower the transaction costs involved in offshoring of R&D (Liu et al., 2011).

The critical knowledge infrastructure variable for R&D offshoring is the level of telecommunications development (Bunyaratavej et al., 2008). Successful control, coordination and transfer of offshored R&D activities depend on the quality, availability and cost of telecommunication infrastructure and telecommunication services. The effectiveness of the telecommunication infrastructure and competitive cost of telecommunications are important factors to be an attractive location for R&D offshoring (Graf & Mudambi, 2005).

S&E clusters are another important part of the knowledge infrastructure of a country. Jensen and Pedersen (2012) argue that S&E clusters are favourable locations for offshoring R&D because of potential spillovers from existing R&D organizations in the local environment, e.g., universities, research centres and innovative rivals. Moreover, Manning et al. (2008) claim that S&E clusters are new geographical concentrations of S&E talent pools and of external service providers that offer technical and other advanced services such as IT, R&D and product design using S&E talent and at the same time compete for such talent.

Even though some studies claim that knowledge infrastructure is an important determinant of location choice for R&D offshoring, there is no exact definition of knowledge infrastructure and what it contains. While some studies argue that the overall infrastructure of a country which includes legal, political, social, communication and transportation infrastructure should be accepted as a determinant of R&D offshoring, other authors claim that the knowledge network between universities, research institutes, S&E clusters and industries, as well as the telecommunication infrastructure are more important for R&D offshoring.

Country risk and firm experience

It was mentioned before that the main framework of this research is based on Dunning's Eclectic paradigm. According to the OLI model, there are three categories of determinants that influence the location decision, government policy, country risk and infrastructure (Dunning, 1988). Country risk includes political risk and economic risk. Some studies distinguish country risk through economic, financial and political risks; however, when examining the R&D offshoring process it will be more appropriate to accept financial risk as a part of economic risk. Economic risk incorporates measures such as the openness of the economic system, the inflation rate and exchange rate fluctuation, the possibility of repatriating profits, with a general assumption of the more change, the more risk. Political risk encompasses aspects including political instability, conflict intensity between nations, and the likelihood of the changes in labour and environmental laws and regulations affecting business and trade. Also, political risks can emerge from the real or threatened expropriation by national governments of foreign-owned assets or the explicit or implicit repudiation of contractual obligations by host governments (Ramamurti, 2001). According to Doh and Ramamurti (2003), the first risk has declined precipitously since the 1960s and 1970s, while the second continues to influence a great deal of offshored activities in developing countries. Moreover, Doh et al. (2009) argue that the potential disruptions to business that arise from political protests, terrorism, and insurrection would be critical to R&D offshoring. Some authors (Bunyaratavej et al., 2011) highlight that the leakage of knowledge has been one of the risks in transferring and offshoring of R&D, especially for those firms that offshore software development activities to India where software piracy is widespread (Chakraborty, Sarker, Rai, Sarker, & Nadadhur, 2011). Because of this, most firms tend to avoid the offshoring of particularly sensitive or volatile service categories to minimize risk (Ellram et al., 2008).

There are also some types of risks not related with country risk, but with doing business abroad. These risks, which include corruption, absence of governance, and the uneven application of laws are especially acute in emerging markets (Metters, 2008). The lack of familiarity with the foreign environment translates into elevated levels of risk-related costs to the firm, which is related with the liabilities of foreignness (LOF) concept (Bunyaratavej et al., 2007). The LOF concept refers to the costs of doing business abroad that result in a competitive disadvantage for firm operation in a foreign country, and these costs include the social, political and economic costs associated with identification and operation as a foreign firm within a particular country context.

Some authors (Bunyaratavej et al., 2007) argue that the main factor which mitigates the risks related with R&F offshoring and costs of doing business abroad is the experience of the firm. Manning et al. (2008) support this argument and mention that experienced companies have learned how to cooperate with non-affiliated suppliers and to restructure their organizations and processes in ways that have reduced their concern with the leakage of knowledge and loss of managerial control. Dossani and Kenney (2003) claim that prior experience of the firm not only mitigates or decreases the risks but also helps firms make better offshoring decisions. Similarly, Manning et al. (2008) highlight that offshoring decisions are affected by firms' past experience and offshoring histories, and argue that firms will not offshore a core activity, such as R&D, without prior offshoring or specific host-country experience. Moreover, Jensen (2009) shows that experience in offshoring acts as a decisive driver of a firm's future offshoring decision. In the literature, experience of firm has been examined from three different perspectives: experience of doing business in the known host country or prior knowledge of the location (Hätönen, 2009), experience of managing the offshoring process (Hätönen, 2009; Rilla & Squicciarini, 2011), and cumulative experience of firm with a technology, which is one of the main factors in offshoring of tacit knowledge (Song & Shin, 2008). While some studies (Jensen & Pedersen, 2012; Maskell et al., 2007) use the learning-by-doing process to describe experience of a firm, other studies (Manning et al., 2008) apply the path dependence concept. However, after analysing the articles examining these concepts it can be concluded that they investigate experience of firm from the same perspective, and the learning-by-doing process is part of the path dependence concept.

Cultural Difference

The existence of similarities in culture between a host country and the home country provides many benefits to a firm. In a more similar culture, firms will likely be able to reduce additional costs that might occur from training and acquiring information (Bunyaratavej et al., 2007). Similarly, Bunyaratavej et al. (2008) found that cultural differences between the home and host country increase the costs of the offshoring of R&D and thus decrease the attractiveness of the location. The reduction of transaction costs in the case of cultural closeness can be explained by similarity of business laws, customs, ways of doing business and possibly familial links (Buckley et al., 2012). Moreover, Liu et al. (2011) argue that cultural closeness mitigates asymmetric information, potential misunderstandings and lack of trust between the offshoring firm and the non-affiliated supplier. Furthermore, expectations between managers and employees are generally better allied in more similar cultures, which tends to lead to less miscommunication, greater trust and better teamwork (Stringfellow et al., 2008). According to the McKinsey Global Institute in 2003, American firms save $0.58 for every dollar of spending on activities they transferred to India, and German firms save €0.52 for every euro of corporate spending offshored to India. Through investigating the reason for this difference, Farrell (2005a) found that the cultural distance between the USA and India is closer than the cultural distance of Germany and India. Moreover, Farrell (2005a) discovered that the favorite location of offshoring for German companies is Eastern Europe, because of cultural closeness.

Common language constitutes one important element that bridges cultural distance and contributes to business exchanges and lowers transaction costs. In some cases, countries which share common language may also share cultural, institutional and historical experience (Doh et al., 2009). Moreover, some types of offshoring services require high levels of home country language facility, so because of the common language some countries can become very attractive locations.

In the literature most of the studies (Bunyaratavej et al., 2011; Bunyaratavej et al., 2007; Doh et al., 2009; Hahn & Bunyaratavej, 2010) use the cultural or psychic distance concept to analyze similarities between countries. However, some studies (Buckley et al., 2012; Mudambi & Venzin, 2010) use a broader framework called CAGE (Cultural, Administrative, Geographical and Economic) to investigate closeness between countries. Economic distance is reflected by factors such as endowment of natural resources, knowledge resources and GDP of the host country (Buckley et al., 2012). In this framework, cultural distance is only part of the whole picture and the discussions are similar to the discussions mentioned above. Administrative distance relates to governance and institutions and is represented though country level linkages. Farrell (2005a) explains this difference in saving of American and German companies by using the cultural distance concept. In addition to this explanation, it can be argued that not only are common language and similar business environment between the USA and India important factors, but also the flexibility of both countries' institutions. Kshetri (2007) argues that the nature of regulative, normative, and cognitive institutions is also a significant component of administrative distance, which is part of the CAGE framework. Geographical distance is one of the important determinants of production or manufacturing offshoring; however, because of recent developments in ICT and cheap communication costs this aspect is not significant for offshoring of services and especially R&D activities.

One of the discussions in the literature is the use of Hofstede's "Country scores" (Hofstede, 1980) to measure cultural distance between countries in the case of R&D offshoring. Some important studies on R&D offshoring (Bunyaratavej et al., 2008; Hahn et al., 2011) have applied Hofstede's "Country scores" to determine the cultural distance between home and host countries. Hofstede's "Country scores" are based on four cultural dimensions: power distance, individualism, masculinity and uncertainty avoidance. Even though it is a useful and important measurement tool of cultural distance, in the case of R&D offshoring it will be more suitable to measure cultural distance between countries based on common language, colonial ties, common history, business environment, institutional distance and ethnic ties. And at the end, although cultural distance has been established as one of the determinants of offshoring for MNCs, it has still been underexplored in offshoring of R&D, particularly from an empirical perspective.

Offshoring as a strategy

Bunyaratavej et al. (2011) argue that firms offshore activities as part of their overall global strategy. In the USA and Western Europe offshoring as a strategy has spread from the largest MNCs to smaller companies. Kedia and Lahiri (2007) claim that offshoring is the part of the overall corporation strategy to focus on core functions. In addition to the core competency argument, Lewin et al. (2007) propose that companies engage in offshoring as part of their growth strategy to develop the effectiveness and efficiency of business activities by cost saving in low wage countries. Moreover, the firms from small countries, where shortage or lack of qualified personnel exist, use access to talent pool strategy in order to get access to plentiful human capital which is deficient at home (Jensen & Pedersen, 2010). Furthermore, Lewin et al. (2009) found that the managerial objective of increasing speed to market is another major factor underlying the location decision of offshoring. According to this study, firms offshore product development activities in order to speed up their innovation process and to introduce products on the market quicker (Lewin et al., 2009). Even though speed to market is one of the major determinants for offshoring of product development activities, it is not valid for basic and applied research activities since the main purpose of research activities is quality and value added rather than speed to market.

Firm Performance

Despite the growing interest in offshoring, many studies have looked at the causes (Bunyaratavej et al., 2007; Demirbag & Glaister, 2010; Doh et al., 2009; Hahn, Doh, & Bunyaratavej, 2009b; Lewin et al., 2009) in a fine grained way, but do not provide an adequate analysis of the effects. The relationship between offshoring and performance is one of the areas of research yet to be investigated deeply. The majority of the research examining the impact of offshoring on performance at the firm level has investigated the firm performance only circumstantially, except the studies of Bhalla, Sodhi, and Son (2008); Gilley and Rasheed (2000); Leiblein and Miller (2003).

The comparatively limited studies done at the firm level have not reached any consensus on the relationship between offshoring and performance (Loess, Miller, & Yoskowitz, 2008). On the one hand studies have found that offshoring improves performance (Bryce & Useem, 1998), but on the other hand other studies have found that these sourcing strategies have a negative impact on firm performance (Amaral et al., 2006).

Furthermore, there is another set of studies that has empirically tested the relationship between offshoring and performance and has found no significant relationship at the firm level (Aron & Singh, 2005; Bhalla et al., 2008; Gilley & Rasheed, 2000; Mol, 2005). Gilley and Rasheed (2000) investigated the influence of offshore outsourcing on the firm performance and the moderating role of firm level strategy and environmental dynamism. The results of research reveal that there is no significant direct relationship between offshore outsourcing and performance, but there is a difference in the influence depending on the strategy of the company. According to Gilley and Rasheed (2000), there might be a relationship between offshore outsourcing and performance at the individual functional areas which their data did not capture at the firm level. Aron and Singh (2005) also detected that many companies had mixed firm performances from offshoring.

The contradictory findings in the literature on the offshoring and performance relationship could be because most of the prior research was done only with the company as the unit of analysis and performance was measured as total sales or profits of the firm (Bhalla et al., 2008; Gilley & Rasheed, 2000). Firm performance is a function of many different internal and external factors and it is difficult to find statistically significant effects of a single strategy on performance. For instance, when Mol (2005) measured the performance effects at the company level and did not find any significant relationship, the author suggests the use of better measures of project level performance such as reliability, quality and innovation. These studies display that further research is required to investigate this relationship between performance and offshoring at the project level (Gilley & Rasheed, 2000; Mol, 2005; Mol, Pauwels, Matthyssens, & Quintens, 2004).

Another reason for the inconsistent and inconclusive findings on this relationship could be due to lack of control for self-selection strategy (Leiblein & Miller, 2003). Decision makers make strategy choices based on their expectation of future performances. For instance, a firm which offshores its activity does so expecting the highest returns for this strategy compared to others. These decisions are not random and there are many observable and unobservable factors that influence the strategic decision making process. By simply regressing performance on strategy without controlling for self-selection, researchers are assuming that strategic decisions are random and that they are including all the factors that influence performance in the regression (Shaver, 1998). Lack of control for self-selection introduces biases in the estimation due to endogeneity of ownership and location decisions. Despite the widespread use of the self-selection technique, as proposed by Heckman (1979), in the economics literature, the management field has not adopted it for studying strategy and performance relationship (Antonietti & Cainelli, 2008).

Knowledge Transfer

There are several definitions of knowledge transfer in the literature. It can be defined as the “modification of the existing knowledge to specific context” (Foss & Pedersen, 2002). It can also be referred to as a movement of knowledge resulting from dyadic exchanges between source and recipient organizational units (Szulanski, 1996). Knowledge transfer can prove to be a very complex process especially in situations where the MNCs have geographically dispersed units and face global competition. MNCs face barriers to knowledge transfers created by their geographical dispersion and other factors like lack of communication facilities, cultural differences, lack of infrastructure and resources to name a few. The knowledge barriers often create transaction costs. If these costs are greater in external markets (inter firm transfers) than in internal markets (intra firm transfers), then it promotes the choice of MNCs as an organizational form (Buckley & Casson, 1976; Buckley et al., 2012). MNCs could thus be viewed as an “international network that creates, assesses, integrates and applies knowledge” across geographically scattered locations to create value from the knowledge (Almeida, 1996). There are several institutional arrangements that MNCs resort to when it comes to dealing with cross border knowledge, which includes mergers and acquisitions, alliances, joint ventures and licensing arrangements (Bresman et al., 1999). Acquisitions, for instance, are used by MNCs as a means to gain access to knowledge and expand their knowledge base rapidly. In this regard, MNCs are found to be superior to alliances in building and managing knowledge across borders (Almeida, Song, & Grant, 2002). Academics have investigated intra-organizational knowledge transfers (Ambos, Ambos, & Schlegelmilch, 2006; Björkman, Stahl, & Vaara, 2007; Fey & Furu, 2008), inter-organizational knowledge transfers (Dhanaraj, Lyles, Steensma, & Tihanyi, 2004; Muthusamy & White, 2005; Park, 2011), and knowledge spillovers (Gupta & Subramanian, 2008; Hallin & Holmström Lind, 2012) to local competitors, customers and suppliers.

Knowledge transfer could also occur between individuals or groups and not necessarily at organizational levels (Alavi & Leidner, 2001; Hedlund, 1994). Knowledge transfer can also be classified based on the direction of flow: i) conventional transfers from the foreign parent to affiliated units, ii) reverse transfers from affiliated units to parent and iii) lateral or horizontal transfers between affiliated units (Ambos et al., 2006).

Besides the direction of knowledge transfers, the dimensions of knowledge involved in the transfer is also equally important. Knowledge was initially viewed from an objective perspective, as a fixed asset (explicit) possessed by the organization which is implemented via rules, procedures and work practices. In contrast to this earlier view, a subjective perspective (Polanyi, 1966) evolved which adds another dimension, and treats knowledge as the property of the individual (tacit) which comes from experience and is superior to the objective knowledge. This has led to knowledge transfer literature considering both explicit and tacit dimensions of knowledge (Dhanaraj et al., 2004). It also needs to be noted that both these states of knowledge are mutually dependent and not dichotomous (Alavi & Leidner, 2001). The concept of architectural and component (Henderson & Clark, 1990) knowledge has also gained a lot of attention. While component knowledge deals with the specific knowledge of a component unit, architectural knowledge pertains to the knowledge that integrates the component knowledge to form a holistic system. Similarly, the literature has distinguished between the "knowing what" and "knowing how" with the latter being the ability to put the former into practice (Brown & Duguid, 1998).

Knowledge transfer also has different dimensions to it. The different dimensions of knowledge transfer attempted in the literature include the "extent of knowledge transfer" (Gupta & Govindarajan, 2000; Harzing & Noorderhaven, 2006), "degree of knowledge transfer" (Minbaeva, 2007), "frequency of knowledge transfer" (Håkanson & Nobel, 2001; Monteiro, Arvidsson, & Birkinshaw, 2008), "benefits of knowledge transfer" (Ambos et al., 2006), “quality and quantity of knowledge transfer” (Björkman et al., 2007), “satisfaction from knowledge transfer” (Li & Hsieh, 2009), “efficiency and effectiveness of knowledge transfer” (Ciabuschi, Dellestrand, & Martín, 2011), “comprehension, usefulness, speed and economy of knowledge transfer” (Pérez-Nordtvedt, Kedia, Datta, & Rasheed, 2008) and “knowledge transfer effort” (Rabbiosi, 2011). While the focus on some of these studies is on the transfer itself, the others focus on the benefits of the transfer. It can also be noticed that some of these studies deal with not a single dimension of knowledge transfer but with multiple dimensions. Another aspect to be considered is the level of analyses of knowledge transfer to indicate whether it has been conducted at unit level (nodal) either at the recipient or source end, or at the dyadic level involving both the units or at a systemic level at the network level (Gupta & Govindarajan, 2000). There have been very few studies conducted at dyadic level (Ambos et al., 2006; Mäkelä & Brewster, 2009; Szulanski, 1996) when compared to the nodal level studies (Dhanaraj et al., 2004; Fey & Furu, 2008; Gupta & Govindarajan, 2000; Pérez-Nordtvedt et al., 2008). Studies have also looked at the transfer of individual and collective knowledge (Jane Zhao & Anand, 2009) and internal, network and cluster knowledge (Foss & Pedersen, 2002). Other than these the literature also deals with the other levels of analysis like at the transfer level (Jensen & Szulanski, 2004; Zander & Kogut, 1995).

The terminologies used by the scholars to indicate knowledge transfer also vary such as knowledge transfer (Björkman et al., 2007; Jane Zhao & Anand, 2009; Jensen & Szulanski, 2004), knowledge flow (Gupta & Govindarajan, 2000; Monteiro et al., 2008), knowledge exchange (Harzing & Noorderhaven, 2006), knowledge diffusion (Ghoshal & Bartlett, 1988), knowledge sharing (Mäkelä & Brewster, 2009) and knowledge acquisition (Lyles & Salk, 1996; Park, 2011). The earlier studies on knowledge transfer were developed based on Shannon and Weaver (1949) communication theory. The focus of this body of literature is on the sender, receiver, the transmission channel and the noise in the transmission. Based on this, the knowledge transfer studies consider the value of knowledge transferred, motivational disposition of the sender and receiver, the absorptive capacity and the richness of the communication channels to be the main determinants (Gupta & Govindarajan, 2000; Harzing & Noorderhaven, 2006). It is argued that this perspective fails to account for the nature of the relationship between the involved units which also involves the social context and transformational nature of the knowledge transfer (Becker-Ritterspach, Saka-Helmhout, & Hotho, 2010). This means that the process of learning in knowledge transfers needs to be situated in the associated social context (Lave & Wenger, 1998). The close association between organizational learning and knowledge transfer has led to studies where knowledge transfer has been used as a proxy for organizational learning (Dhanaraj et al., 2004). However, it needs to be noted that the learning associated with knowledge transfer is said to materialize when the transferred knowledge leads to some form of modification or transformation within the organization.

Studies on organizational knowledge transfer are also found to adopt an HR perspective focusing on the HR related aspects like compensation mechanism and other related motivational aspects that improve employee learning and performance (Björkman et al., 2007; Mäkelä & Brewster, 2009; Minbaeva, 2007; Minbaeva et al., 2003; Minbaeva, Makela, & Rabbiosi, 2012). This perspective is based on the human capital theory of Becker (1964) and agency theory (Eisenhardt, 1989), which states that incentive based and behavioral based mechanisms aid in the achievement of organizational goals and this has been borrowed in the knowledge transfer literature as well (Björkman et al., 2007; Fey & Furu, 2008). Another perspective used extensively in knowledge transfer studies is socialization theory (Van Maanen & Schein, 1977) which deals with the impact of socialization mechanisms that enhance inter-personal ties between organizational units thus enabling knowledge transfer

(Björkman, Barner-Rasmussen, & Li, 2004). The social capital perspective (Ghoshal & Bartlett, 1988) deliberates on the effects of dyadic factors like trust, commitments, conflicts, shared vision, mutual respect and collaboration on knowledge transfer (Muthusamy & White, 2005). The social exchange theory (Blau, 1964) also prescribes to this line of thought that social exchanges improve the relationship between the associated parties. When it comes to geographically dispersed organizational units that are embedded in the institutional environments of their respective host and home countries, their institutional profiles could be very different or similar. In such situations, institutional theory (Scott, 1987) has been used to understand the effect of institutional profiles on cross border knowledge transfer (Björkman et al., 2007). Specifically, the educational and research institutes, IPR regimes, other knowledge based infrastructure, social and cultural differences are very relevant in the context of knowledge transfers.

Most of the empirical research on knowledge transfers has concentrated on factors that facilitate or hinder it (Minbaeva et al., 2003). As discussed earlier, while some of the studies deal with the communication and socialization between organizational units (Ghoshal & Bartlett, 1988), others have also focused on motivational aspects and control mechanisms (Björkman et al., 2004; Gupta & Govindarajan, 2000). Similar research has analyzed the effects of knowledge characteristics like degree of codification (Zander & Kogut, 1995), knowledge ambiguity (Simonin, 1999), knowledge relevance (Schulz, 2003) and internal stickiness (Szulanski, 1996). Another concept that has received wide attention is the effect of the recipient's absorptive capacity on knowledge transfers (Cohen & Levinthal, 1990). The role of social capital and relevance of social networks on knowledge exchange and the resulting innovation have also been investigated (Millar & Choi, 2009). The competitive strength of the host country that captures the location factors especially in relation to the home country also dictates the dynamics of the knowledge transfer (Ambos et al., 2006).

Knowledge attributes

Prior research has stressed the importance of taking into account the knowledge characteristics of the transferred knowledge as they influence the manner in which organizational mechanisms could be effectively used to facilitate knowledge transfer (Björkman et al., 2004). Knowledge characteristics like tacitness and causal ambiguity have been found to impede knowledge transfers (Jensen & Szulanski, 2004; Szulanski, 1996; Zander & Kogut, 1995). Causal ambiguity leads to a situation which causes a lack of understanding of the logical linkages between action and outcome or causes and effects when it comes to technical or process know-how. Causal ambiguity reduces the prospects of learning and knowledge exchange in the case of transfer of organizational practices (Szulanski, 1996). Knowledge ambiguity is the resistance to clear communication, its contextual embeddedness and its idiosyncrasy (Hedlund, 1994). The ambiguity in knowledge could be very well compared with concepts like 'internal stickiness' as explained by Szulanski (1996) or "difficulty to imitate" (Foss & Pedersen, 2002), "inertness of knowledge" (Kogut & Zander, 1992), "sticky information" (Von Hippel, 1994) and "transferability" (Grant, 1996). Aspects that contribute to the ambiguity of knowledge in terms of knowledge characteristics including tacitness, complexity and asset specificity have been investigated (Simonin, 1999). This ambiguity pertaining to knowledge negatively influences the transfer of knowledge.

Tacit knowledge when compared to explicit knowledge is highly abstract and needs more human involvement when it comes to transmission (Dhanaraj et al., 2004). Tacit knowledge is often referred to as the glue that holds together the explicit knowledge. Tacit knowledge cannot be easily communicated mostly because of its non-codified and contextual nature and hence is difficult to transfer (Simonin, 1999). It has a cognitive dimension to it which makes it more personal and linked to experience and gives the firm a competitive edge. Hence the tacit knowledge is considered more valuable and hence the transfer of the same could prove to be crucial for organizations. Tacitness to a large extent could be attributed to the codifiability (degree to which it can be encoded), teachability (easiness to train) and complexity of knowledge (Kogut & Zander, 1993). The more codified the knowledge, the more the knowledge will be transferred (Schulz, 2003). This is also very closely connected to articulability of the knowledge which facilitates knowledge transfer (Bresman et al., 1999). Managerial and marketing expertise is considered more tacit than product development, production and technological knowledge, being embedded within the organization, not essentially codified, and experiential in nature (Zander & Kogut, 1995).

Asset specificity influences ambiguity of knowledge (Reed & Defillippi, 1990). This specificity could be related to the specialized nature of the investments made in terms of human assets, equipment and facilities (Simonin, 1999). When the knowledge possessed is highly specific in nature, it makes it more difficult to be replicated and hence is crucial for the concerned unit to sustain competitiveness. Hence there is scope for opportunistic behavior which could prove to be a barrier for knowledge transferability. Studies have confirmed the negative influence of specificity on knowledge transfer of new product development and manufacturing skills (Park, 2011). Complexity of knowledge could be linked to the number of inter-dependent technologies, routines, individuals, and resources linked to a particular knowledge (Simonin, 1999). This also has to do with the totality of knowledge and the ease with which it could be comprehended. The more complex the human or technological system, the more the related ambiguity which could restrain imitation and transferability (Reed & Defillippi, 1990).

Relevance of knowledge could be defined as the connectivity and applicability of the knowledge to the given context (Yang, Mudambi, & Meyer, 2008). This aspect of knowledge is significant because knowledge also evolves through the continuous incorporation of the new knowledge into existing knowledge. Knowledge relevance has also been defined as the "degree to which external knowledge has the potential to connect to local knowledge" (Schulz, 2003). Knowledge has the capability of changing other knowledge that is related to it (Schulz, 2003). If all other factors concerning the source, recipient and the knowledge remain the same, the more knowledge connected to the existing knowledge, the more effective the transfer. As per the relevance theory, the similarity in knowledge helps the receiving unit to understand the implications of this knowledge and prompt them to assimilate and use it for their own benefit (Yang et al., 2008). The HQ could be more interested in knowledge flows from the subsidiary units which are strategically more relevant for their operations and this may overtake knowledge relevance also. The unit's absorptive capacity is also highly related to the pre-existing stock of knowledge (Szulanski, 1996). This connectedness in knowledge also improves the firm's capability to learn (Gupta & Govindarajan, 2000). The attractiveness of the knowledge source in terms of its value, rareness, inimitability and non-substitutability is also crucial for the firm to sustain its competitive edge. Novelty of knowledge is found to facilitate knowledge transfer (Pérez-Nordtvedt et al., 2008).

Social Capital

Social capital is a term used to illustrate the extent of social relations between individuals or units within an MNC network (Frost & Zhou, 2005). Some conceptual frameworks have highlighted the importance of these factors on knowledge transfer (Millar & Choi, 2009). The relational dimension of social capital includes elements like trust, obligation, respect and friendship which facilitate knowledge transfer. The cognitive dimension which consists of the shared meanings and interpretations contributes to an improved relational dimension which in turn helps knowledge transfer. The structural element deals with the social ties or networks and their configuration which affects the cognitive and relational dimensions (Bartlett & Ghoshal, 1989).

The positive influence of these different dimensions of social capital on knowledge transfer in MNCs has been demonstrated by several studies (Fey & Furu, 2008; Harzing & Noorderhaven, 2006; Mäkelä & Brewster, 2009; Park, 2011). Relational embeddedness, in terms of trust, shared values, and social ties between the units helps overcome knowledge barriers thus improving the process of mutual learning (Dhanaraj et al., 2004; Ghoshal & Bartlett, 1988; Jensen & Szulanski, 2004). Millar and Choi (2009) stress the effects of cognitive barriers in reverse transfer and the need for developing social ties to improve the same. Psychological contracts that involve trust, mutually shared expectations and emotional ties are likely to facilitate reverse knowledge transfer. Trust between organizational units helps get rid of any fears related to opportunistic behavior and they in turn become more willing to share information (Dhanaraj et al., 2004). It should also be noted that while elements like trust between international joint venture (IJV) partners positively influence the extent of learning and knowledge transfer, conflicts between IJV partners are found to adversely affect the process of knowledge transfer (Lyles & Salk, 1996). Arduous relationships or conflicts in general between source and recipient units adversely affect knowledge transfer, while strong relationships and ties between the units facilitate knowledge transfer (Pérez-Nordtvedt et al., 2008). Shared vision helps the units to see the common goals and objectives that they have and realize the potential benefits from sharing benefits (Park, 2011).

The effect of the three dimensions of social capital on knowledge transfers are seen to be more significant when the transferred knowledge is tacit (Dhanaraj et al., 2004). It is seen that tacit knowledge transfers demand more social interactions and stronger inter-personal ties since tacit knowledge is more closely linked to personal experiences. Reciprocal commitment and mutual power influence between alliance partners are also found to influence the transfer of organizational practices (Muthusamy & White, 2005). These practices are highly embedded in the organizational context which makes social interactions even more pertinent when it comes to knowledge transfers. The degree of involvement that a unit has with the rest of the MNC network (Minbaeva et al., 2003), active involvement by foreign parent in an IJV (Lyles & Salk, 1996), management support by foreign parent in IJV also positively influence knowledge transfer (Park, 2011).

CHAPTER 3 – HYPOTHESIS DEVELOPMENT AND CONCEPTUAL MODEL

Background

Deciding where to locate activities is one of the most significant strategic decisions involved in offshoring of R&D. The location decision is tightly related to and largely based upon the initial make or buy decision (Hätönen, 2009). A review of literature on determinants of location choice for R&D offshoring shows that the majority of research is at the country level and most studies examine country level factors. Early studies argue that cost saving is the main determinant of offshoring (Farrell, 2004, 2005a; Granstrand, 1999; Hakanson & Nobel, 1993). However, the recent studies indicate that for a growing number of MNCs reducing labour costs is no longer the primary determinant behind their offshoring decisions, especially as they are increasingly offshoring more high value added activities which require qualified personnel (Demirbag & Glaister, 2010; Doh et al., 2009; Lewin et al., 2007; Lewin et al., 2009; Lewin & Peeters, 2006). Moreover, Dossani and Kenney (2003) discovered that even though offshoring firms were initially attracted to India for reduction of costs, they continued offshoring and expanding affiliates because of the high quality of the personnel. Also, Doh (2005) claims that the abundance and quality of the talent pool are increasingly important determinants of offshore location decisions.

The literature also indicates that the strength of a country's National Innovation System (NIS) is an important determinant of R&D location decision for MNCs (Demirbag & Glaister, 2010). The NIS includes knowledge institutions (R&D labs and research universities as well as standards, quality and metrology institutes) and other R&D performing enterprises (local or foreign), along with an institutional framework for R&D and innovation. A strong NIS, where knowledge institutions have tight links with production enterprises and other firms that perform world class R&D, is a major draw to MNCs looking for new R&D locations. The presence of dynamic science parks can be an additional attraction to R&D that requires interaction with a diverse range of firms and institutions. A diverse industrial structure, with technologically complex activities, is likely to provide clusters with the skills and linked suppliers and buyers that can support R&D. Countries with strong technological specialization tend to attract MNC R&D in similar areas, and MNCs tend to offshore R&D to complement their strengths (Florida, 1997). According to Reddy (2000), one of the attractive features of India for offshoring of R&D is the existence of internationally reputed R&D institutes such as the Indian Institute of Technology, Indian Institute of Science, Indian Institute of Chemical Technologies and Centre for Drug Research. Many of the MNC R&D units in India collaborate with these institutes and several MNCs that do not have an R&D unit in India offshore R&D to these institutes (Reddy, 2000).

Intellectual Property Right (IPR) regime is one of the important parts of the NIS framework. It is often mentioned as a factor that might influence the location choice of MNC's R&D. Econometric analyses of United States MNCs found that IPR protection was a significant determinant of where foreign R&D activities were performed, but not a significant factor between different developing country locations (Le Bas & Sierra, 2002). Bransletter et al. (2004) found that R&D spending by the affiliates of United States MNCs increased after IPR reform in host countries.

Government policy or incentives related to R&D is another aspect of the NIS framework. However, in general, incentives of government are effective only when other, more important determinants are in place. By reducing costs, government incentives may induce MNCs to expand or deepen their R&D activities. However, if the necessary skills and research capabilities are lacking, incentives may induce firms merely to re-label routine technological activities and report them as R&D.

The extensive literature on determinants of location choice has primarily focused on country level factors such as labor cost (Lewin & Peeters, 2006), infrastructure and legal environment of host country (Demirbag & Glaister, 2010; Demirbag et al., 2010b), country risks (Demirbag et al., 2010a), and cultural differences (Bunyaratavej et al., 2007; Doh et al., 2009). Only some studies have examined the firm level factors like R&D networking (Howells, 2008), growth strategy of the company (Manning et al., 2008; Manning et al., 2010) and economies of scale and scope (Blinder, 2006). However, there is a lack of studies investigating the drivers of location choice at the project or task level.

In the prior literature, Reich (1991) emphasized the importance of task characteristics, pointing out that the globalization of the world's economy entailed a divide between standardized tasks in developing countries and high value added tasks in developed countries, where the right knowledge and skills are available. He also claimed that all jobs of knowledge workers are subject to relocation considerations. Bardhan and Kroll (2007) also have similar considerations regarding the level of task complexity and the possibilities for transferring these tasks across companies and locations. However, certain value chain activities, such as R&D, are often treated as a single constellation, even though the firm's activities within, e.g., R&D or IT, really consist of many specific and different tasks, some executed by highly educated specialists and others not (McCann & Mudambi, 2005). Each activity consists of many tasks, and it is necessary to take these into account when explaining the dynamics, complementarities, and the more specialized division of labour among the different tasks at the aggregated level. Furthermore, companies rarely offshore entire activities like manufacturing, logistics, marketing or R&D; they offshore only some tasks or projects related to these activities.

Analysing the literature review on R&D offshoring, it was concluded that a disaggregated perspective focusing on the task or project level should be one of the important aspects of this research. However, the drivers of R&D offshoring at the country and company level should not be ignored. Based on transaction cost economics, resource-based view and eclectic paradigm, this thesis proposes that the determinants of location choice should be investigated at three levels: country level, firm level and project or task level. All three groups of drivers should be studied individually and together, and each level should have its own determinants.

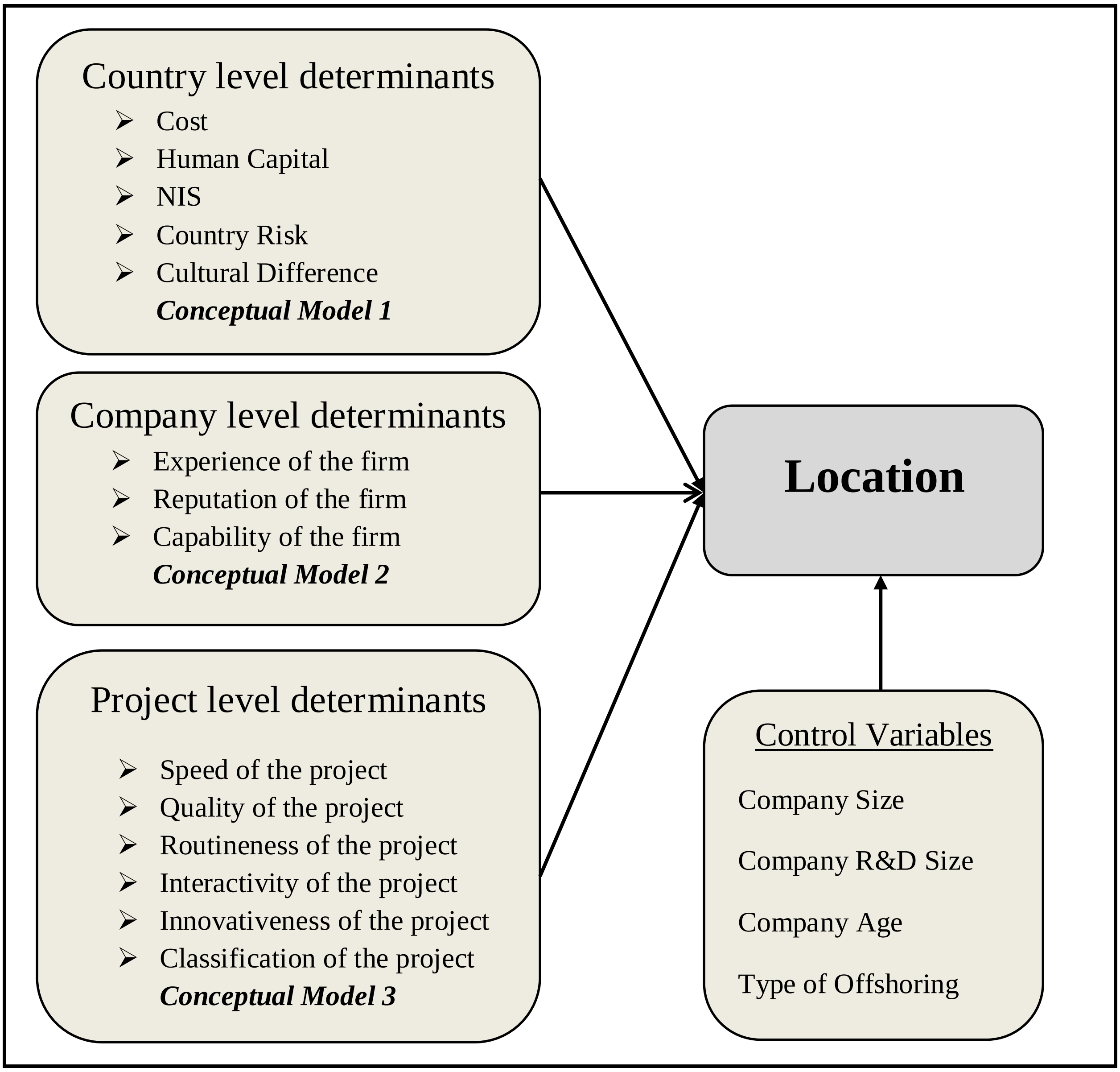


Figure 3: Full Model
Adopted from Demirbag and Glaister (2010).

Country Level Factors

Based on model 1 in Figure 4, the study proposes to look at the five different country level variables that could potentially influence the location choice of R&D offshoring. In order to attract R&D projects and activities, countries must have a large pool of talent or R&D personnel to perform offshored R&D activities and have a strong and competitive NIS. Further, the risk of the country should be at the minimum level, so MNCs can operate their activities. Furthermore, the lower the wage of the personnel and cheaper the cost of doing R&D projects in a country, the more attractive the location. And, the closer the cultural difference between the home and host country, the more advantageous the host country. Hence, the thesis looks at the effects of cost, human capital, NIS, country risk, and cultural difference for the first model.

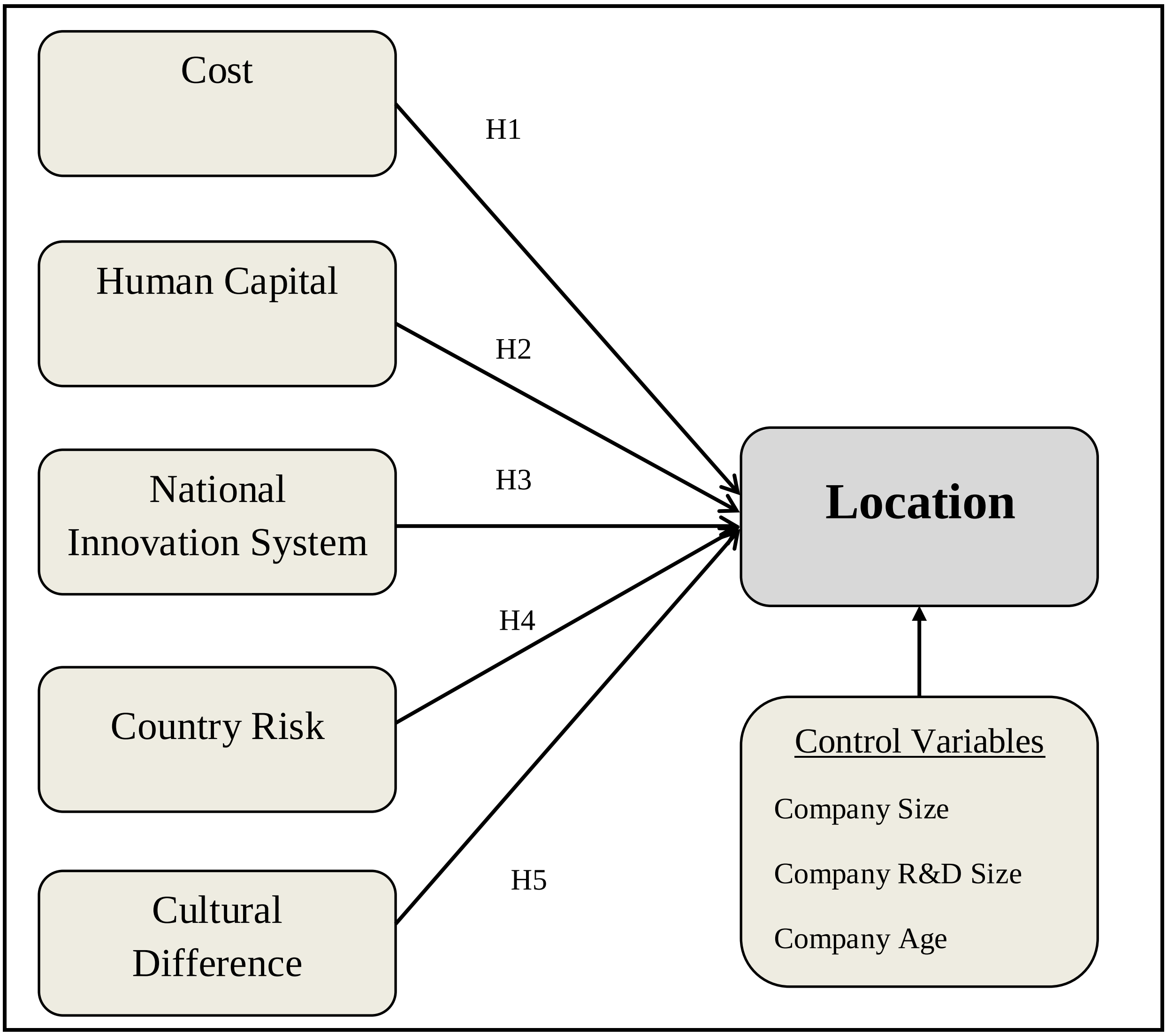


Figure 4: Conceptual Model 1
Adopted from Demirbag and Glaister (2010).

Cost

Cost undoubtedly remains an important determinant in location choice of the offshoring process, especially for basic and routine activities (Bunyaratavej et al., 2007). This statement was confirmed by the recent survey of Duke University CIBER and Consulting (2005) on offshoring which showed that 93% of the respondents referred to cost saving as the most important factor of offshoring (Lewin et al., 2007). Also, the research on offshoring by Farrell (2005b) found that the US and German MNCs save approximately half of the budget of the project by offshoring it to India rather than doing the project at home, which further supports the statement that cost is still one of the main determinants of offshoring.

While cost saving from offshoring has been an important factor for basic and routine activities, such as call centres, the importance of cost saving for offshoring of high value activities, such as R&D has not been investigated deeply. The literature on offshoring of R&D claims there are three groups of factors which result in cost saving: i) cost saving due to the difference in wages between developed and emerging countries (Doh et al., 2009; Hahn et al., 2011), ii) cost saving due to the difference in infrastructure, tax and regulatory costs between developed and emerging countries (Jensen & Pedersen, 2011), and iii) cost saving due to the consolidation of activities in fewer locations, and from the economies of scale (Bunyaratavej et al., 2008). While most of the literature on R&D offshoring investigating cost saving is focused on the difference in wages between developed and emerging countries and on the difference in infrastructure, tax and regulatory costs between developed and developing countries (Bunyaratavej et al., 2008; Doh et al., 2009; Hahn et al., 2011), only limited research has been done on economies of scale (Jensen & Pedersen, 2011).

Furthermore, offshore outsourcing has the potential to reduce costs as companies can convert fixed costs into variable costs (Young, Swan, Thomchick, & Ruamsook, 2009), and reduce capital invested by accessing external competencies and resources (McFarlan & Nolan, 1995). Since non-integrated suppliers specialize in a narrow range of R&D activities and often serve multiple companies, they benefit from economies of concentrated scale which reduce their operating costs. Even though economies of scale is one of the ways the firms can reduce the cost of activities, the largest share in cost saving comes from wages between developed and developing countries and on the difference in infrastructure, tax and regulatory costs between developed and developing countries. Therefore countries providing low R&D wage and low costs on doing R&D projects and activities will be potential R&D offshoring locations (Kedia & Mukherjee, 2009). Hence, I hypothesize that:

Hypothesis 1: The more important the cost factor as a determinant in the location choice decision of R&D offshoring, the greater the likelihood of developing and emerging countries being selected as R&D offshoring locations.

Human Capital

For some firms, cost reduction is no longer the only determinant behind offshoring decisions (Bunyaratavej et al., 2007); especially when the firm is offshoring not only standardized information technology or business processes, but also starting to offshore innovative activities such as basic and applied research, product design, software applications, engineering and development activities (Demirbag & Glaister, 2010). The survey of Duke University CIBER and Consulting (2005) on offshoring indicated that access to human capital was the second most important determinant of offshoring after cost saving, and that new product development – including R&D, product design and engineering services – was the second most frequently offshored activity after IT.

A recent report from IBM illustrated that a pool of talent in emerging and developing countries grows at a great pace by highlighting that there were over 115,000 scientists with Master of Science Degrees in Chemistry, and 12,000 more with Chemistry PhD Degrees in India. Furthermore, a growing young population, growing investments in improving higher education systems, and increasing domestic career opportunities in emerging countries like India and China are also important factors in the creation of a talent pool.

On the other hand, recent research has shown that the number of US and Western European citizens graduating with science and engineering master and PhD degrees has been stagnating or even declining since the mid-1990s (Athey, 2004; Erken & Gilsing, 2005a). Whereas the cost of R&D offshoring is still an important determinant in location choice, recent studies have discovered that firms are offshoring their activities to locations with a large pool of qualified personnel. Hence, I hypothesize that:

Hypothesis 2: The larger the pool of science and engineering talent in a country, the greater the likelihood of that country being selected by MNCs as an R&D offshoring location.

National Innovation System

It was hypothesized above that the cost of the R&D project and human capital of the location are important determinants of location choice for R&D offshoring. The literature on offshoring highlights that there is one more factor, which is also as important as the factors mentioned before (Graf & Mudambi, 2005; Kedia & Lahiri, 2007). The research by Lewin et al. (2009) claimed that the cost saving and human capital factors should be analysed together. Demirbag and Glaister (2010) argued that not only human capital, but also knowledge infrastructure and National Innovation System (NIS) should be investigated in conjunction with cost saving factor, since there is a trade-off between these determinants. The research on

Japanese MNCs revealed that the stronger the NIS of the host country, the more likely that the country will attract R&D offshoring (Shimizutani & Todo, 2008).

One of the main components of NIS is the presence of high quality institutions. Better legal institutions tend to provide the enforcement of contracts, support greater transparency in the business environment, and decrease uncertainty about legal rights. Also, the better the quality of the institutional environment, the lower the transaction costs involved in offshoring of R&D (Liu et al., 2011). The existence of a well-developed and feasible intellectual property right (IPR) system in a country is also an important component of NIS and results in a high quality of institutions (Kshetri, 2007). The results from an UNCTAD (2005) survey showed that IPR develops the environment for innovative R&D activities and stated that countries with strong IPR protection have a significant advantage in terms of attracting R&D offshoring.

Technology and R&D clusters are another important part of NIS. The recent study on technology clusters found that these clusters are favourable locations for offshoring R&D because of potential spillovers from existing R&D organizations in the local environment, e.g., universities, research centres and innovative competitors (Jensen & Pedersen, 2012). Furthermore, R&D clusters are new geographical concentrations of qualified R&D personnel and of external service providers that offer technical and other advanced services such as IT, basic and applied research, development activities and product design (Manning et al., 2008).

According to a general definition of NIS, telecommunication infrastructure is another main component of NIS (Bunyaratavej et al., 2008). Successful control, coordination and transfer of offshored R&D activities depend on the quality, availability and cost of telecommunication infrastructure and telecommunication services. Availability of telecommunication infrastructure and competitive cost of telecommunications are significant conditions that locations need to fulfil in order to be an attractive location for R&D offshoring (Graf & Mudambi, 2005). Hence, I hypothesize that:

Hypothesis 3: The stronger the National Innovation System of a country, the greater the likelihood of that country being selected as an R&D offshoring location.

Country Risk

MNCs face a wide range of risks when entering a foreign market or offshore R&D activities (Demirbag & Glaister, 2010). The literature on offshoring mentions that there are two main types of country risks against which MNCs should struggle (Hahn et al., 2011). Economic risk which is the first type of country risk incorporates measures such as the openness of the economic system, the inflation rate and exchange rate fluctuation, the possibility of repatriating profits, with a general assumption of the more change, the more risk (Bunyaratavej et al., 2007). While another type called political risk encompasses aspects including political instability, conflict intensity between nations, and the likelihood of the changes in labour and environmental laws and regulations affecting business and trade. Also, political risks can arise from the real or threatened expropriation by national governments of foreign-owned assets or the explicit or implicit repudiation of contractual obligations by host governments (Ramamurti, 2001). The first type of risk has decreased precipitously since the 1960s and 1970s, while the second continues to influence a lot of activities offshored to developing countries (Doh et al., 2009).

According to the recent study of Bunyaratavej et al. (2011), the leakage of knowledge has also become one of the risks in the transferring and offshoring of R&D, especially for those firms which offshore software development activities to emerging countries where software piracy is widespread (Chakraborty et al., 2011). Because of this, most of the firms tend to avoid the offshoring of particularly sensitive or volatile service categories to minimize risk (Ellram et al., 2008). Also, the risks such as corruption, absence of governance, and the uneven application of laws threaten the offshoring of high value activities especially to emerging markets (Metters, 2008). Based on the above discussion, it is proposef that country risk is an important factor in the location decision of R&D offshoring. Hence, I hypothesize that:

Hypothesis 4: The more important the country risk factor as a determinant in the location choice of R&D offshoring, the lower the likelihood of developing and emerging countries being selected as R&D offshoring locations.

Cultural Difference

The existence of similarities in culture between a host country and the home country provides many benefits to a firm. In a more similar culture, firms will likely be able to reduce additional costs that might occur from training and acquiring information (Bunyaratavej et al., 2007). Similarly, Bunyaratavej et al. (2008) found that cultural differences between the home and host country increase the costs of the offshoring of R&D and thus decrease the attractiveness of the host location. The reduction of transaction costs in the case of cultural closeness can be explained by similarity of business laws, business mentality, customs, ways of doing business and possibly familial links (Buckley et al., 2012). Moreover, Liu et al. (2011) argue that cultural closeness mitigates asymmetric information, potential misunderstandings, and lack of trust between the offshoring firm and non-affiliated supplier. Furthermore, expectations between managers and employees are generally better allied in more similar cultures, which tends to lead to less miscommunication, greater trust and better teamwork (Stringfellow et al., 2008). According to the McKinsey Global Institute in 2003, American firms save $0.58 for every dollar of spending for projects they offshored to India, while German firms save €0.52 for every euro of corporate spending offshored to India. By investigating the reason for this difference Farrell (2005a) found that the cultural distance between the USA and India is closer than the cultural distance between Germany and India. In addition to this, Farrell (2005b) discovered that not only are common language and similar business environment between the USA and India important factors in this process, but also the flexibility of both countries' institutions. Moreover, Farrell (2005a) discovered that the favorite location of offshoring for German companies is Eastern Europe, because of cultural closeness.

Common language as a main component of cultural closeness constitutes one important element that bridges cultural distance and facilitates business exchanges and lower transaction costs. In some cases, countries that share a common language may also share cultural, institutional and historical experience (Doh et al., 2009). Moreover, some types of offshoring services require high levels of home country language facility, so because of the common language some countries can become very attractive locations. Therefore, I hypothesize that:

Hypothesis 5: The closer the cultural difference between home and host country, the greater the likelihood of that host country being selected as an R&D offshoring location.

Company Level Factors

Based on model 2 in Figure 5, the study proposes to look at the three different company level variables that could potentially influence the location choice for R&D offshoring. The literature on offshoring highlighted that the country risk is one of the main determinants. Therefore, higher political and economic risks in the country lower the chance that MNCs will offshore R&D activities to that location. However, the recent studies argue that the experience of the MNC could eliminate or at least mitigate the effects of the country risk factor. Furthermore, the reputation and capability of the companies can play a huge role in this decision. Hence for model 2, the thesis analyses the effects of the experience of offshoring R&D activities, reputation and capability of the firms.

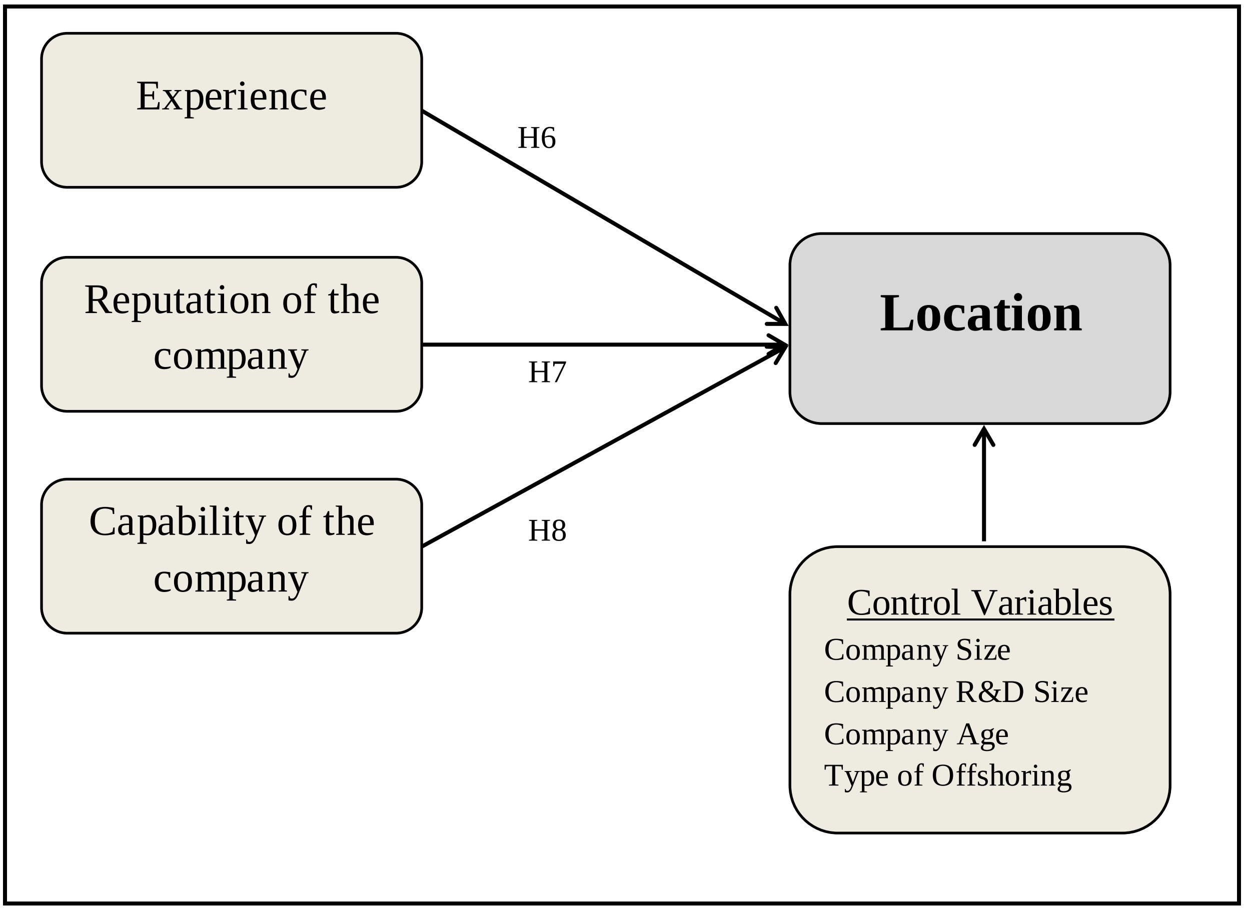


Figure 5: Conceptual Model 2
Adopted from Demirbag and Glaister (2010).

Experience

The international business literature on offshoring argues that experience of the firm can mitigate the risks related with R&D offshoring and costs of doing business abroad (Bunyaratavej et al., 2007). The recent research on offshoring found that experienced firms have learned how to collaborate and manage non-integrated suppliers and to restructure their organizations and process in ways that have lessened their concern with the leakage of knowledge and loss of managerial control (Manning et al., 2008). Also, the experience of the firm not only mitigates and decreases the risks, but also improves the effectiveness of the location decision of the firm in the case of offshoring (Le Bas & Sierra, 2002; Patel & Vega, 1999). Furthermore, Lewin et al. (2009) highlighted that without any prior offshoring or specific host-country experience firms do not offshore any core activities.

In the literature there are three different types of firm experience which have an influence on the offshoring decision: i) experience of doing business in the known host country or prior knowledge of the location (Hätönen, 2009), experience of managing the offshoring process (Hätönen, 2009; Rilla & Squicciarini, 2011), and cumulative experience of the firm with a technology which is one of the main factors in the offshoring of tacit knowledge (Song & Shin, 2008). Based on the discussion above, I hypothesize that:

Hypothesis 6: The more experienced the offshoring company, the greater the likelihood of the emerging and developing country being selected as an R&D offshoring location.

Reputation

One of the main firm level determinants of R&D offshoring is the reputation of the firm and brand. There is extensive research on the reputation of the firm (Belt & Paolillo, 1982; Gatewood, Gowan, & Lautenschlager, 1993); top managers of firms pay attention to the impact of the decision on the firm's reputation and firm's brand, when considering different strategy options. The firm's reputation is an intangible asset which can be a source of future revenues (Wilson, 1985). When a firm is undertaking some strategic decisions it should consider the impact on the reputation and brand of the firm. Research has shown that reputation has a positive impact on the strategies adopted by the firm (Weigelt & Camerer, 2006).

Offshoring of high value added activities such as R&D is an important strategic yet controversial decision, which can have negative consequences on the firm's reputation. Offshoring has been blamed for job losses in the home country, while offshoring to emerging and developing countries has been questioned for quality purposes. The threat to a firm's reputation and brand is greater in offshoring to emerging and developing countries than offshoring of R&D activities to developed countries. Thus it is proposed that firms are less likely to engage in offshoring of R&D activities to emerging and developing countries to maintain impressions with the customers, employees, suppliers and shareholders.

Hypothesis 7: The more important the reputation of the firm, the lower the likelihood of developing and emerging countries being selected as R&D offshoring locations.

Capability

Each organization has a fundamentally different predisposition to exploit resources, evaluate their value, assimilate them, and apply them to final goods. This has been termed the firm's ''capability'' (Barney, 1991). According to the resource-based view of the firm, firm-specific capabilities are critical to a firm's success (Conner, 1991; Conner & Prahalad, 1996). Supporting this underlying theory, empirical research has shown that distinctive technological, marketing, and managerial capabilities can be value creating for firms (Rugman & Verbeke, 2002).

To leverage the offshoring vendor's technical expertise, the technical capability of the firm is important. Technical capability involves technical knowledge and skills needed to develop applications, while managerial capability implies knowledge of where and how processes are deployed effectively and profitably to meet strategic business objectives. Vendor management capability which is looking beyond an existing contractual arrangement to explore long-term relations with suppliers can create a win–win situation. This should facilitate the vendor's participation in the offshoring.

Although the resource-based view provides insight into what types of capabilities are likely to generate value, comparatively little attention has been devoted to how capabilities impact the offshoring of high value activities. The firms with strong firm specific capabilities can offshore core activities to emerging markets, since they can control activities and can benefit, while it is hard to say the same thing for the firms with weak capabilities. Hence, I hypothesize that:

Hypothesis 8: The weaker the capabilities of the offshoring firm, the lower the likelihood of the emerging and developing country being selected as an R&D offshoring location.

Project Level Factors

Within the offshoring context, Porter's (1985) "Value Chain" concept often serves as a useful template. Analysing the value chain includes disaggregating it into specific activities which create value for customers. By disaggregating their value chain into discrete pieces – some to be performed at home, others to be offshored to different countries – a firm hopes to decrease overall costs and risks. Recent research (Thakur, 2010) shows that firms are engaged in a micro-analysis and dissection of their value chain into finer slices than ever before. The value chain is no longer divided into large groupings such as R&D, production or marketing. The functions and operations within each category can be sliced into dozens or hundreds of sub-activities or tasks. For each sub-activity or task the question then asked is where to perform it and whether to perform it within the company or outsource it (Contractor et al., 2010). Even within R&D, which is still considered as a core activity that should not be offshored, one can disaggregate various functions, keeping sensitive aspects in-house, while offshoring others. Moreover, Jensen and Pedersen (2010) show that companies rarely offshore an entire activity like R&D or IT, instead offshoring only some of the tasks or sub-activities. The same research also demonstrates that some tasks in the same value chain activity can be relatively advanced, while other tasks can be relatively simple. For instance, in addition to its more advanced tasks like basic research or applied research, R&D includes less advanced, standardized, and routine tasks, such as tests, patent application and documentation (Jensen & Pedersen, 2010). So I argue that this stage of the location decision process should be analysed based on the characteristics of tasks or projects which will be offshored, since this paves the way for a richer understanding of offshoring strategies and processes. Based on model 3 in Figure 6, the study proposes to look at the six different project level variables that could potentially influence the location choice decision of R&D offshoring. In model 3, the thesis analyses the effects of classification, routineness, interactivity, innovativeness, speed and the quality of the R&D projects.

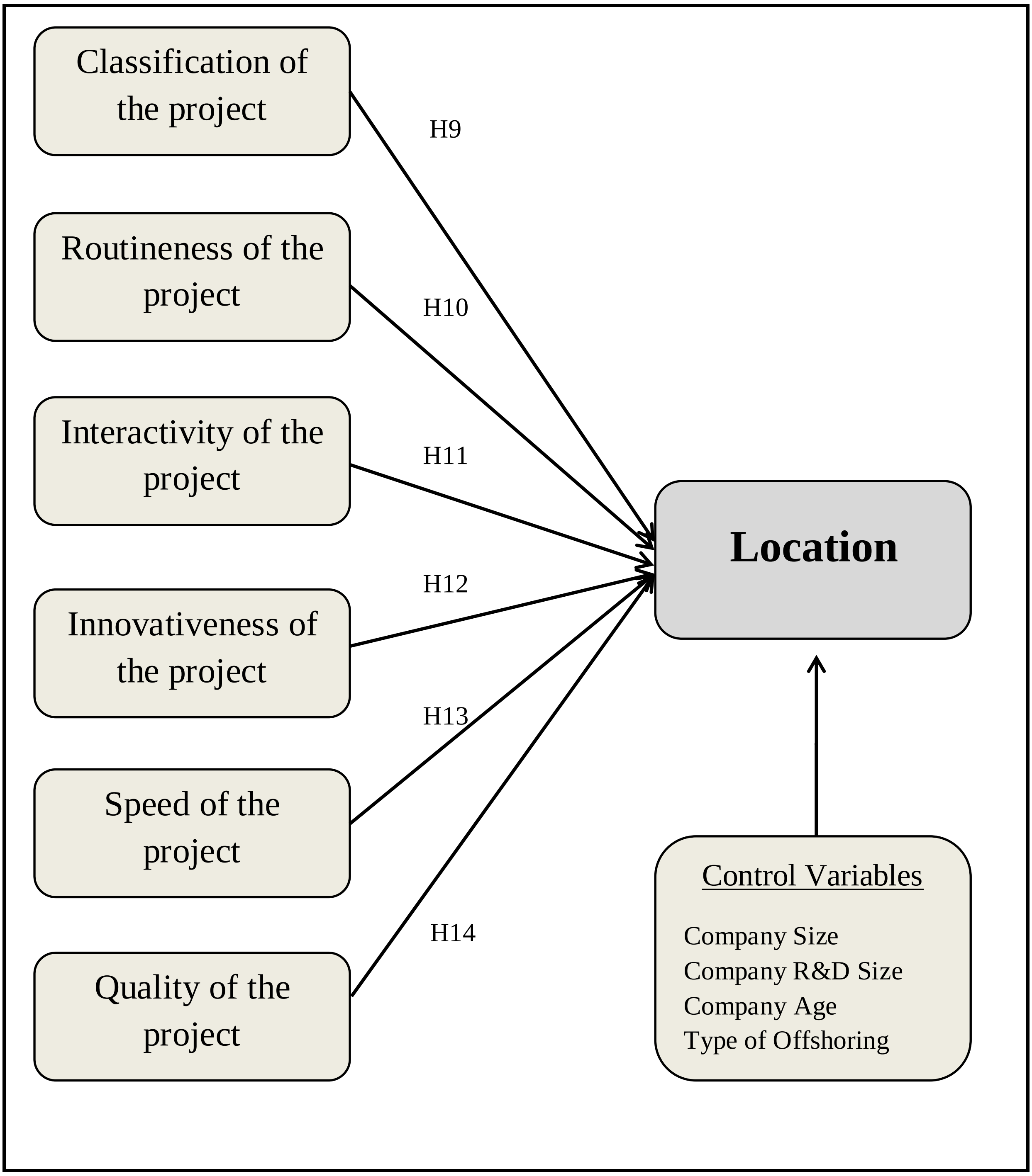


Figure 6: Conceptual Model 3

Adopted from Demirbag and Glaister (2010).

It was discussed that R&D can be sliced into many constituent pieces and offshored to different locations. The critical point here is which part of R&D should be offshored to which location or country? In this context, the literature divides tasks or projects into core and non-core activities in order to determine where to offshore that activity or to keep it in-house (Levy, 2005). According to the TCE and RBV theories, companies should keep their core activities or tasks at home to protect the core competences. Offshoring of core activities may imply a risk of knowledge leakage and loss of control. However, the recent studies show that firms have started to offshore their core activities. Contractor et al. (2010) explain this trend by redefining the concept of core and non-core activities. They argue that tasks can be divided into three categories.

(1) *Core activities* are those that the firm performs better than any other company and if the firm gives those activities to an external party, it would be creating a competitor or dissolving itself.

(2) *Essential activities* are those that are needed for sustaining its profitable operations and if not performed exceptionally well, can place the firm at a competitive disadvantage or even create a risk. For example, logistics is a critical but non-core activity for a producer, but it is a core activity for a transportation company.

(3) *Non-core activities* are those activities which supply no competitive advantage and can be easily offshored. Even if performed poorly, they are less likely to seriously harm the firm in the short term, although they are still important.

In addition to this, previous studies have identified three main motives for offshoring of R&D. The first motive is cost saving by lowering operational costs, controlling cost, and freeing resources for more profitable activities. The second is related to process improvement, and the need to concentrate on core competences, to achieve flexible internal reorganization, to accelerate projects, gain access to a flexible workforce, and to sharpen business focus. And the third motive is capability enhancement, which includes obtaining access to highly skilled talent unavailable internally and improving service quality. Analysing the concept of core and non-core activities with the motives of R&D offshoring, it can be concluded that cost saving is the main motive and cost factor is the main determinant for offshoring of non-core R&D activities. Consequently, if the cost saving is the main motive for offshoring of non-core R&D projects, it would be beneficial for MNCs to offshore this project to an emerging or developing country. Hence, I hypothesize that:

Hypothesis 9: Other things being equal, non-core R&D projects are more likely to be offshored to developing and emerging countries.

In the literature several recent studies have identified the characteristics of tasks or projects which affect the location decision of MNCs. According to Levy and Murnane (2012) service activities can be divided into routine and non-routine. Moreover, Doh et al. (2009) mention that activities possess four attributes: heterogeneity, intangibility, perishability and simultaneity. Furthermore, Blinder (2006) highlights the need for personal interaction when delivering service. In this research, characteristics of projects will be examined in order to explain the location choice decision of MNCs.

Routineness: Routine and repetitive tasks "can be accomplished by following a set of rules" (Levy & Murnane, 2012). The more a task can be specified by asset of rules, the easier it is to explain to third party suppliers without substantial misunderstanding, and the easier it is to control (Yu & Levy, 2010). This indicates low transaction costs for offshoring routine activities. Dossani and Kenney (2009) take this argument further and declare that "transaction costs do not matter if firms offshore only routine R&D projects such as field tests and documentations". So, it can be concluded that if an offshoring project is repetitive or routine, it will be beneficial for MNCs to offshore this project to emerging or developing countries. Hence, I hypothesize that:

Hypothesis 10: The more routine the R&D project, the greater the likelihood of emerging and developing countries being selected as R&D offshoring locations

Interactivity: Some service activities may require interaction between the provider and customer (Blinder, 2006; Doh et al., 2009). The success of any offshoring relationship with a high degree of interactivity will depend on the ability to communicate effectively between the parties. Speaking in the same language, having the same business culture and mentality would substantially help improve service quality, reliability, and efficiency. Misunderstandings between the offshoring firm and the service provider may prove costly to the offshoring firm. Thus, in the case of offshoring of interactive R&D tasks the countries with close cultural or psychic distance to the home country should be chosen in order to avoid misunderstandings and improve efficiency. Hence, I hypothesize that:

Hypothesis 11: The more interactive the R&D project, the greater the likelihood of a country which has closer cultural difference with the home country being selected as an R&D offshoring location.

Innovativeness: Lewin et al. (2009) report that global hubs of innovation are developing in specific geographies around the world, many of which are still dependent on foreign participation and investment. They document the increasing willingness of highly sophisticated companies to consider offshoring innovative activities to emerging markets such as India, China, and Eastern and Central Europe. They also mention that certain countries in Central and Eastern Europe as well as in South Asia specialize in attracting particular R&D activities from companies based in particular regions of the world. Hence, Iit is suggested that innovation will influence the location of specific offshoring tasks. Projects such as basic and applied research that have a relatively high level of innovation require a strong knowledge infrastructure and strong NIS. As a result, firms will look to offshore these projects to countries that have competitive knowledge infrastructure and strong NIS, not to emerging and developing countries. Hence, I hypothesize that:

Hypothesis 12: The more innovative the R&D project, the lower the likelihood of emerging and developing countries being selected as R&D offshoring locations

One important aspect in offshoring of R&D projects is the speed in completion of the project. Offshoring improves the speed of completing the project by giving the firm access to large human capital (Carmel & Schumacher, 2005). Speed from offshoring is also achieved due to round the clock work hours across continents (Lewin et al., 2009).

External sourcing through non-integrated suppliers also improves the speed of the R&D process in a firm (Kessler, Bierly, & Gopalakrishnan, 2000). According to Quinn (2000), offshore outsourcing speeds up the innovation process especially in high technology industries such as pharmaceuticals, biotechnology and semiconductors, since suppliers have greater knowledge depth and innovate at a faster rate. Non-integrated suppliers located in the emerging and developing countries can be faster due to their large dedicated team of workers and also because they focus on a narrow range of activities (Holcomb & Hitt, 2007).

According to Contractor et al. (2010), speed of project completion is especially important for the pharmaceutical and biotechnological R&D projects, since there are time costs involved.

Time costs are the costs incurred from lost sales opportunities due to the delay in development of a drug or another important discovery whose patent clock is ticking. Since drug development is an extremely lengthy process, the time costs involved are very important to the firm. Speed can be increased from offshoring due to less strict regulations of governments in emerging and developing countries (Bunyaratavej et al., 2008). The duration of R&D projects also can be decreased due to the abundant supply of qualified R&D personnel in emerging countries. Based on the discussion and evidence above, I hypothesize that:

Hypothesis 13: The more important the completion speed of the R&D project in the location choice decisions of R&D offshoring, the greater the likelihood of emerging and developing countries being selected as R&D offshoring locations.

Offshoring is not just a cost saving process, since it is also important to maintain the quality of the R&D activity. There is often a trade-off associated between cost and quality especially when offshoring in the service sector and to emerging and developing countries. According to (Bunyaratavej et al., 2007), firms often tend to give greater importance to quality when facing intense competition at home. While some researchers have found quality to be an important determinant of offshoring, they have also found that poor quality service is one of the highest perceived risks of offshoring (Lewin & Peeters, 2006). As evinced in the study of Levy (2005), the quality of offshored projects to emerging and developing countries is often a concern due to lack of face to face communication and low quality of regulatory institutions in the country.

Some quality related challenges from offshore outsourcing are the failure of the foreign vendor to perform according to the requirements, and lack of competence (Perry & Devinney, 1997). Quality can also be lower in offshore outsourcing since the non-integrated supplier may have an incentive to save money by offering poor quality services and products (Embleton & Wright, 1998). While these drawbacks are possible in both developed and emerging countries, weakness of knowledge infrastructure and juristic system in emerging and developing countries makes quality a greater concern in offshoring of projects into these countries. Thus, it is proposed that when quality is of high importance for a particular R&D project, then firms are more likely to offshore them to developed countries rather than emerging and developing countries.

Hypothesis 14: The more important the quality of completed R&D projects in the location choice decisions of R&D offshoring, the lower the likelihood of emerging and developing countries being selected as R&D offshoring locations.

The degree of innovativeness and routineness of the offshored R&D activities

According to Porter (1985), activities within the firm's value chain can be broadly divided into three categories: the upstream or input end, the downstream or output end, and the middle. Activities at the upstream end generally comprise design, basic and applied research, and the commercialization of creative ideas and thoughts. Activities at the downstream end typically comprise marketing, advertising and brand management, and after-sale services. Activities in the middle comprise manufacturing, standardized service delivery and other repetitious processes in which commercialized prototypes are implemented on a mass scale (Porter, 1985). The trends of last century mechanization and standardization have reduced the cost of manufacturing and logistics processes. Processes supporting mass customization have become widely available and subject to rapid imitation (Mudambi, 2008). This in turn has reduced the scope for the use of such processes to generate the differentiation required to support value creation. It is difficult for firms to extract high value-added from both tangible products and standardized services (Maskell et al., 2007). Firms are finding that value-added is becoming increasingly concentrated at the upstream and the downstream ends of the value chain. Activities at both ends of the value chain are intensive in their application of knowledge and creativity (Mudambi, 2007).

Activities at the input or upstream end are supported by R&D knowledge (basic, applied research and design), while activities at the output or downstream end are supported by marketing knowledge (marketing, advertising and brand management, sales and after-sales service). The pattern of value-added along the value chain may, therefore, be represented by the "smile curve" or the "smile of value creation" as shown in Figure 7 (Mudambi, 2007).

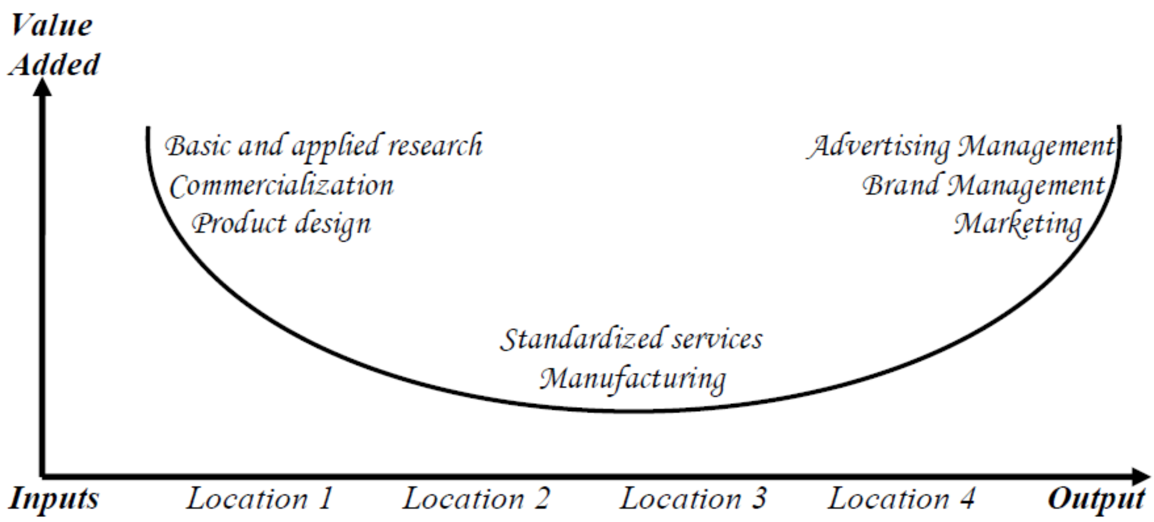


Figure 7: The smile curve of value chain (Mudambi, 2007)

The geographic realities associated with the smile of value creation are that the activities at the ends of the overall value constellation are largely located in advanced and developed economies, while those in the middle of the value chain are moving or have moved to emerging and developing economies (Contractor et al., 2010; Jensen & Pedersen, 2010; Mudambi, 2008).

The review of literature on offshoring has shown that there are noticeable changes in the strategy of firms: i) the division of the firm's value chain into ever smaller pieces, and ii) the willingness to offshore even activities close to core competencies of the firm. Firms are engaged in a micro analysis and dissection of their value chains into finer slices than ever before (Jensen & Pedersen, 2010). The value chain is no longer divided into large activities like R&D, but disaggregated into dozens of small activities such as basic and applied research, design and new product development. The high costs and risks of R&D, and the competitive need to shorten commercialization times have made firms more willing to disaggregate at least some safer and discrete portions of their R&D and allocate those pieces to foreign affiliates or non-integrated suppliers beyond the national borders. For example, in the R&D activities of pharmaceutical and biotechnology companies, firm secrets are kept at home, while the clinical trial portion of research is increasingly being offshored (Contractor et al., 2010).

Activities considered to be "core" or of high strategic importance can, nevertheless, be deconstructed into sub-activities that are routine and others that remain tacit, proprietary, and secret. Certain research and intellectual assets are properly treated as highly proprietary and never to be offshored. But other aspects of the R&D function are mundane, and can be systematized, and codified with the help of IT systems, e.g., patent application and product design. What used to be considered one monolithic block in the company's value chain is now amendable to micro-dissection into its component sub-routines.

By applying the "smile curve" or "smile of value creation" concept to value chain of R&D activities, where instead of value-added in the y-axis, degree of innovativeness of the R&D task or project is used, the picture can be created in Figure 8.

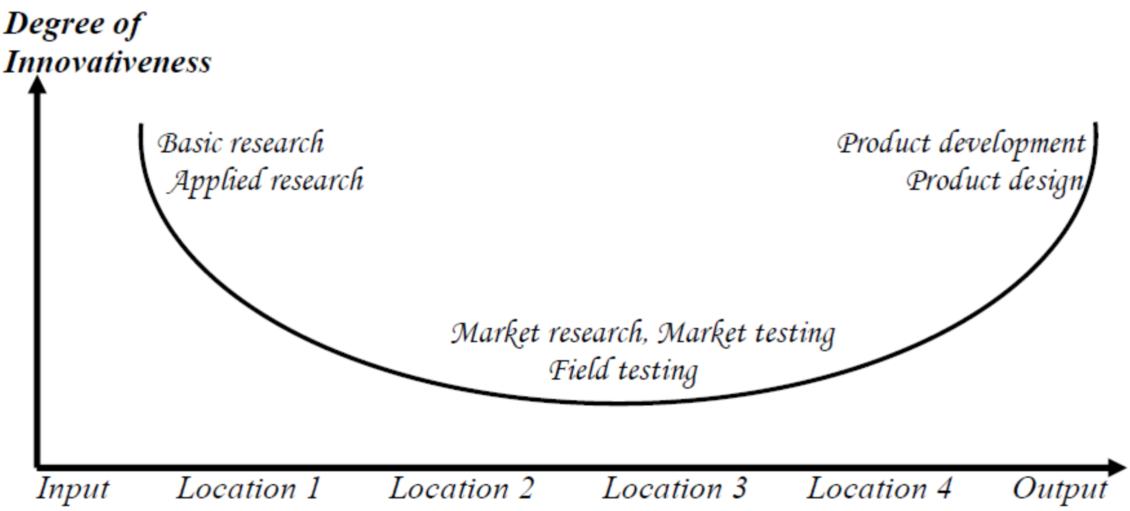


Figure 8: The smile curve of R&D value chain, adopted from Mudambi (2007).

It was mentioned before that under the current location pattern, high value-added activities are largely performed in advanced market economies, while low value-added activities are performed in emerging and developing economies. Based on the discussion above it is proposed that R&D activities with higher degree of innovativeness are more likely to be offshored to advanced or developed countries, while the R&D activities with a higher degree of routineness are more likely to be offshored to emerging and developing countries.

Hypothesis 15: Other things being equal, the degree of innovativeness of the R&D activities offshored to developed countries is higher than the degree of innovativeness of the R&D activities offshored to emerging and developing countries.

Hypothesis 16: Other things being equal, the degree of routineness of the R&D activities offshored to emerging and developing countries is higher than the degree of routineness of the R&D activities offshored to developed countries.

The disaggregation and routinization in R&D has been aided by the increased codification of corporate knowledge. Procedures that used to be just in the mind of engineers or managers are now put down in written routines, software, or expert systems (Maskell et al., 2007). Once codified, the manuals or software can be read, absorbed and implemented even outside the firm by non-integrated suppliers. The codification of knowledge increases the likelihood of captive offshoring and offshore outsourcing. However, it might also increase the likelihood of technology leakage. The firm can prevent this opportunism by sharing only a discrete bit of the whole innovative R&D task or entire routine R&D projects with non-integrated providers, so as not to put the whole innovative R&D activity together to become a competitor. Based on this case, it is proposed that the higher the degree of innovativeness of the offshoring R&D project, the higher the likelihood of this project being offshored to foreign affiliates. While the higher the routineness of the offshoring R&D task, the higher the likelihood of the task being offshored to non-integrated suppliers.

Hypothesis 17: Other things being equal, the degree of innovativeness of the R&D activities offshored to foreign affiliates of the firm is higher than the degree of innovativeness of the R&D activities offshored to non-integrated suppliers.

Hypothesis 18: Other things being equal, the degree of routineness of the R&D activities offshored to non-integrated suppliers is higher than the degree of routineness of the R&D activities offshored to foreign affiliates of the firm.

CHAPTER 4 - RESEARCH METHODOLOGY

Chapter overview

The previous chapters drew attention to the lack of empirical research at the project level of the offshoring literature and distilled a number of hypotheses on the determinants of the location choice decision and the difference between the degree of innovation and routineness of the R&D activities offshored to foreign affiliates of the firm and to non-integrated suppliers. This chapter discusses the methodology employed to conduct the empirical investigation through which the generated hypotheses will be tested.

According to Sumner and Tribe (2004), for a well-considered research design two important and intimately related issues should be addressed: (i) "the epistemological choice"; and (ii) "the methodological choice". While the former deals with the philosophical assumptions underpinning the nature of knowledge and the methodological foundation of the research (Krogh, Roos, & Slocum, 1994; Nodoushani, 2000), the latter refers to the more practical side of it (Trochim, 2006). Along these lines of thinking, this chapter begins by exploring the nature of the research according to its purpose and context while also offering a critical discussion of its epistemological assumptions. After a statement on the research approach and on the strategy adopted, a discussion of the rationale underpinning the selection of the data collection method will be offered. The final section of the chapter will consider the sampling strategy, the selection of the sampling method frame, questionnaire development, data collection process and factor analysis.

Understanding the nature of the research

One way to gain an understanding of the nature of the research is to explore the position it occupies within the "basic-applied research continuum" (Easterby-Smith, Thorpe, Jackson, & Lowe, 2008; Saunders, Saunders, Lewis, & Thornhill, 2011) and to try to study its overall purpose using a three-fold classification that differentiates between three different groups of research, namely: (i) exploratory, (ii) descriptive; and (iii) explanatory research (Neuman & Kreuger, 2003; Robson, 1993).

As far as the basic and applied types of research are concerned, while the former is generally undertaken within academia and aims mainly at increasing knowledge and our understanding of business phenomena; the latter is primarily aimed at applying solutions in relation to specific organisational problems (Saunders et al., 2011; Sekaran, 2006). Since this research, which is undertaken as part of a doctoral program within a university setting, aims to make a contribution to academic knowledge by investigating the determinants of the location choice decision and the difference in the degree of innovation and routineness of the R&D activities offshored to foreign affiliates of the firm and to non-integrated suppliers, it is located more towards the basic end of the research spectrum. Nevertheless, given the fact that this research cannot be seen in isolation of its practical implications on outsourcing practice within organisations and since its outcomes could be of great value to managers, it also contains elements that push its purpose towards the other end of the (applied) research spectrum.

As noted earlier, in order to gain a deeper understanding of the nature of the research, one should try to understand its purpose using the three-fold classification that differentiates between exploratory, descriptive and explanatory types. Exploratory research answers the question of "what is happening?" (Robson, 1993) and could be a valuable means of finding out "what is going on?" (Schutt, 2011). It tends to look for patterns and hypotheses and helps the researcher gain an insight and become more familiar with a subject area through the adoption of mainly qualitative techniques for gathering data (Neuman & Kreuger, 2003; Schutt, 2011) via, for example, a literature survey (Saunders et al., 2011). Descriptive research focuses on providing an accurate picture of a particular event, situation or relationship (Neuman & Kreuger, 2003; Robson, 1993). It involves the adoption of mainly quantitative data-gathering techniques (Neuman & Kreuger, 2003). Finally, explanatory research tends to answer the "why" question by identifying the reason for something through, for example, the establishment of causal relationships between variables. It typically involves testing theoretical predictions or hypotheses using statistical techniques (Neuman & Kreuger, 2003; Saunders et al., 2011; Schutt, 2011).

In line with the argument of Robson (1993), which suggests that the purpose of enquiry could change over time, the research undertaken during the course of this thesis began as exploratory and then moved towards an explanatory nature. Indeed, following an initial exploratory mapping of the offshoring literature, a specific area that required a more rigorous investigation became the focus of the research. This led to the identification of mechanisms and determinants of the location choice decision, which are to be subjected to empirical scrutiny in this study through hypothesis testing and statistical inference.

The epistemological framework

Epistemology, which originates from the Greek word "episteme", could be defined as a philosophical concept that is related to the nature and scope of knowledge (Trochim, 2006). It provides the philosophical underpinning that legitimises knowledge and the framework for a process that will produce, through a rigorous methodology, answers that can be believed to be valid, reliable and representative (Sumner & Tribe, 2004). Although it tends to be overlooked

(Saunders et al., 2011) or simply reduced to the task of choosing between paradigms (Campbell, 2002), discussing the epistemological underpinnings of a given research project has become increasingly important and somewhat unavoidable (Bryman & Bell, 2007). Blaxter, Hughes, and Tight (2010, p. 59) frame the issue well:

"The question `which method is best? ' is not solely about whether, for example, to use interviews, questionnaires or observations. Underpinning these research tools are more general philosophical questions about how I understand social reality... "

Since the choice of the research philosophy has a direct implication on the overall research approach employed and ultimately on the data collection method to be used (Collis & Hussey, 2003), it is important to begin with an exploration of the epistemological perspectives and philosophical stance of the research (Johnson & Duberley, 2000; Saunders et al., 2011).

The research methodology literature makes reference to two diametrically opposed research philosophies: positivist-empiricist and constructivist-phenomenological (Bryman & Bell, 2007; Fawcett & Hearn, 2004; Lee, 1992; Saunders et al., 2011). While the former is likely to be based on logical reasoning, empirical evidence and used as a means for establishing causal relationships between variables (Collis & Hussey, 2003), the latter tends to be used in qualitative research concerned with interpreting human behaviour and employed as a means to understanding the complexities of the social world (Remenyi, Williams, Money, & Swartz, 1998; Saunders et al., 2011). These two research philosophies could be associated with Burrell and Morgan's objectivism-subjectivism locus where at one end of the spectrum the researcher is independent of the object of investigation (objectivism) and where, at the other end, I find a more involved researcher trying to understand the rich and complex world he or she is part of (Burrell & Morgan, 1994). With reference to the nature of reality, the two above mentioned philosophical stances, which occupy two extreme poles in the research paradigm debate, could be linked to the representationalism-nominalism ontological dimension (Easterby-Smith et al., 2008). While representationalists contend that truth could be determined by means of prediction-testing, which matches the positivists' position, nominalists assume that truth could be better explored by referring to the labels and names I attach to experiences and events (Easterby-Smith et al., 2008) matching, hence, the phenomenologists' end.

Viewed within its dominant basic explanatory nature as highlighted in the previous section (although it contains elements of both applied and exploratory research purposes) and given its attempt to investigate the determinants of location choice decision and difference of the degree of innovativeness and routineness of the R&D activities offshored to foreign affiliates of the firm and to non-integrated suppliers by means of prediction-testing, the philosophical orientation underpinning our research takes, overall, a positivist stance and leans towards a rather representationalist ontological position.

Nevertheless, as noted by Saunders et al. (2011), in practice research rarely falls neatly into positivist and phenomenological camps. This is echoed by Hammersley (2002) who contends that research cannot always be seen as strictly qualitative or quantitative or also as purely subjective or objective (Trochim, 2006). As such, although this research takes an overall positivist stance, it also contains phenomenological elements that allow for an explanation of the phenomena under investigation (through my interpretation of the gathered data) hence leaning towards what Molteberg and Bergstrom (2000) describe as middle ground pragmatism. The latter reflects the feasibility to employ different methodological approaches that are judged to suit particular research problems (Tashakkori & Teddlie, 1998).

Finally, it should be noted that even though the above discussion on the epistemological stance of this study seems to be solely guided and informed by its suitability to the nature of the research and the type of question to be addressed, it could also be influenced by my epistemological commitment that was at the origin of the development of the research question in the first place. This idea is clearly captured in Johnson and Duberley (2000, p. 1) statement:

"How we come to ask particular questions, how we assess the relevance and value of different research methodologies so that we can investigate those questions..., all express and vary according to our underlying epistemological commitments"

The statement resonates with Lee (1992)'s suggestion that there are always causes that cause causes to cause causes, which, in turn, mirrors Moldoveanu, Baum, and Baum (2002) emphasising the need to produce researchers who are informed about their epistemological commitments and consequently on the importance to consider not only what beliefs researchers hold but also how researchers believe their beliefs.

The methodological framework

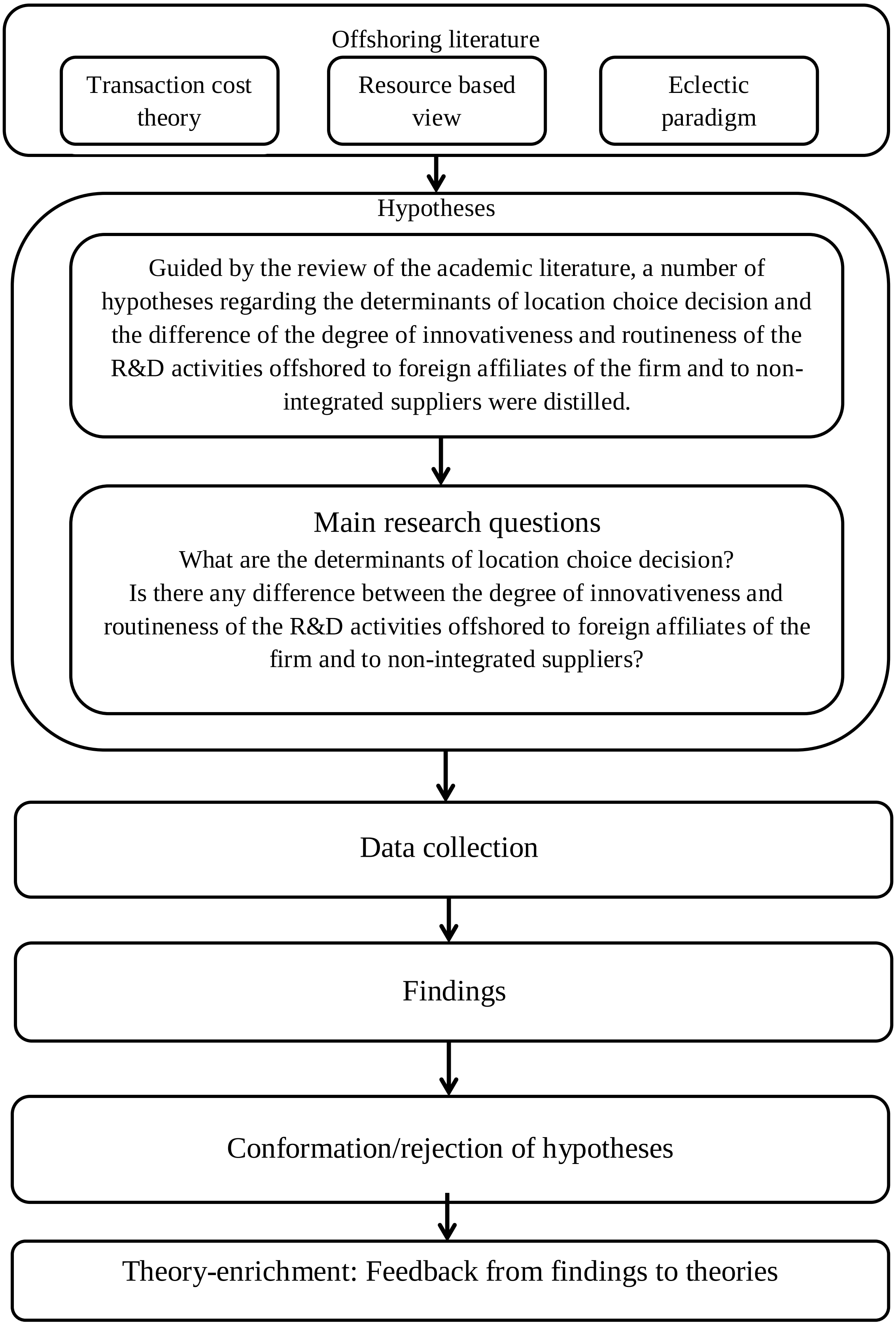
The notion of the methodological framework relates to the way methods are combined in order to generate appropriate research data that could ultimately form the response to the research question (Collis & Hussey, 2003). Consequently, it represents the operationalization of the research question which, in turn, requires reaching a decision on both the research approach and the research strategy to be adopted (Sumner & Tribe, 2004).

Research approach

Research approaches can be broadly classified into two categories: deductive and inductive (Neuman & Kreuger, 2003; Saunders et al., 2011). This classification provides us with a clear schema for the examination of the relationship between theory and research (Bryman & Bell, 2007). Indeed, while the deductive approach, which could be associated with a theory-testing process (Hyde, 2000), moves from a general theory to a specific case indicating a "top-down" progressive sequence (Trochim, 2006), the inductive approach is characterized by its theory-building process (Hyde, 2000; Saunders et al., 2011) that involves drawing generalizable inferences out of observations (Bryman & Bell, 2007).

Since this study moves from the articulation of hypotheses to empirical testing, it is the deductive method of enquiry which best describes the approach pursued in this research project. In fact, focusing on the offshoring literature, a number of hypotheses on the determinants of the location choice decision and the differences in R&D activities offshored to foreign affiliates and non-integrated suppliers will be tested using data from companies. As pointed out by Neuman and Kreuger (2003), the deductive approach can be regarded as a move from a logical relationship among concepts toward concrete empirical evidence (see Figure 9).

Figure 9: The process: Dominant deductive research approach



Source: Adapted from Bryman and Bell (2007) and applied to the author's research.

Nevertheless, it is worth noting that although it might be useful to classify research approaches into deductive and inductive categories, this distinction has been criticised for its inability to reflect the actual approaches adopted by researchers in practice (see Hyde (2000)). Sharing similar views, Blaikie (2007) denied the existence of pure deductive or inductive forms of research and, consequently, proposed a third "abductive approach" that contains some elements of both approaches, hence reflecting a more eclectic form of research that recognises the intertwined nature of different activities in the research process (Dubois & Gadde, 2002). Such an eclectic view, therefore, highlights the importance of regarding the research approach as a phenomenon in motion rather than as a static well-defined process. As stated by Dubois and Gadde (2002) a standardised conceptualisation of the research process as consisting of a number of planned subsequent phases does not reflect the potential uses and advantages of research. The same view seems to be shared by Saunders et al. (2011), who recognise that any rigid divisions between the two approaches (deductive and inductive) would be misleading.

Research strategy and data collection method

Research strategy could be described as a general plan that, with due consideration to the researcher's resource constraints, clarifies how the research question is to be addressed, how the research objectives are to be met, and how required data are to be collected (Saunders et al., 2011). The research methodology literature makes reference to a variety of research strategies including experiment, survey, case study, grounded theory, ethnography and action research (Bryman & Bell, 2007; Robson, 1993; Saunders et al., 2011). According to Easterby-Smith et al. (2008), most research strategies could be associated with different research approaches. Indeed, while the survey strategy is often related to the positivist-deductive approach, strategies such as ethnography or grounded theory are described to fit better with a constructivist-inductive research approach (Easterby-Smith et al., 2008; Saunders et al., 2011). Nevertheless, although these connections between research approaches and research strategies might help researchers select the right strategy in their research journey, these associations alone are regarded as over-simplistic since the final decision should mainly be guided by the research questions and objectives (Saunders et al., 2011).

The main purpose of this research is to test the determinants of the location decision and to test if there are any differences between the degree of innovativeness and routineness of the R&D activities offshored to foreign affiliates of the firm and to non-integrated suppliers. This requires gathering information from a large number of firms, with different sizes, operating in different industries and offshoring different types of activities. As such, given the purpose of the research, the survey strategy was selected as the most appropriate research method among competing alternatives. First, the chosen method provides access to a wide population sample in a highly economic way (Saunders et al., 2011). Second, it is a common approach for conducting business and management research and it is usually associated with the deductive approach that is dominantly employed in this research (Neuman & Kreuger, 2003; Remenyi et al., 1998; Saunders et al., 2011). Third, it allows for the collection of quantitative data that allows for statistical analysis to be carried out (Frankel, Naslund, & Bolumole, 2005). This enables us to fulfil the main objective of this study which essentially involves empirical prediction-testing. Within the survey category, most of the research methodology literature distinguishes between three data collection techniques, namely: (i) structured observation; (ii) structured interviews; and (iii) self-administered questionnaires (Easterby-Smith et al., 2008; Saunders et al., 2011).

Structured observation is often associated with organisation and methods (O&M) research (Saunders et al., 2011) and is most frequently used as part of experiments (Easterby-Smith et al., 2008).

Structured interviews involve asking standardised questions to all interviewees either face-to-face or through the telephone (Collis & Hussey, 2003), allowing the researcher to make sure that the respondent is the particular person to whom they wish to administer the survey (Hair Jr, Celsi, Money, Samouel, & Page, 2011). It should be noted though that this data collection method requires skills similar to those related to in-depth and semi-structured interviews (Saunders et al., 2011).

As for self-administered questionnaires, they usually provide access to wider and more dispersed samples while being accomplished with minimal staff and facilities. They allow respondents time to think about their answers (Schwarz, 2007), provide greater anonymity and, hence, are less likely to result in respondents being tempted to provide pleasing answers (Blumberg, Cooper, & Schindler, 2005). For these reasons, and given my resource constraints, the self-administered questionnaire was selected as the most appropriate data collection method (within the survey category) to be employed. Self-administered questionnaires could be delivered and returned electronically through email (online questionnaire), by post or could also be physically handed to and collected from each respondent (Saunders et al., 2011). In this research the online questionnaire was chosen for a number of reasons. First, online questionnaires are economically less costly. Second, it can be easy to obtain e-mail addresses of companies. Third, given the large number of companies to be targeted, the option of handing the questionnaires physically was considered both impractical and time consuming.

However, although considered as the most appropriate data collection method for this research, the self-administered questionnaire method suffers from a number of drawbacks which researchers must be aware of. Indeed, this method has been primarily criticised for its low response rate generation which, in turn, could be responsible for introducing non-response bias (Blumberg et al., 2005; Bryman & Bell, 2007; Collis & Hussey, 2003; Neuman & Kreuger, 2003). In addition, the self-administered questionnaire method usually raises the risk of missing data occurrence as questionnaires are returned partially uncompleted (Bryman & Bell, 2007). Moreover, while this data collection method limits the type of questions to be employed (for example open questions should be avoided), it also prevents the researcher from further probing, restricting the extent of topic coverage (Bryman & Bell, 2007; Neuman & Kreuger, 2003). Finally, an additional limitation of the self-administered questionnaire is the lack of the researcher's control over the conditions under which questionnaires are completed (Neuman & Kreuger, 2003), an aspect which could potentially affect the reliability of the results.

Given the above-mentioned limitations, particular attention will be paid to the sampling strategy and to the questionnaire structure, design and content so as to reduce bias and enhance the reliability and validity of the research. In so doing, attempts will also be made to increase the potential response rate and reduce the risk of missing data.

Sampling strategy

A sample consists of a subset or a segment of the population that is selected for investigation (Bryman & Bell, 2007). The extent to which the characteristics of a sample represent those of the population from which the sample is drawn dictates the ability to generalise from the sample to the population (May, 2001). Such a generalisation process, which is typically related to the positivistic hypothetical-deductive tradition, calls for a probability sampling approach which is, in turn, commonly associated with survey-based research (De Vaus, 2013; Hair Jr et al., 2011). While probability sampling does not completely eliminate sampling errors, it allows the researcher to employ tests of statistical significance that allow generalised inferences to be made (Bryman & Bell, 2007). However, this would require an adequate definition of the population, an appropriate sample frame, and a properly selected sample (De Vaus, 2013).

Population and sample frame

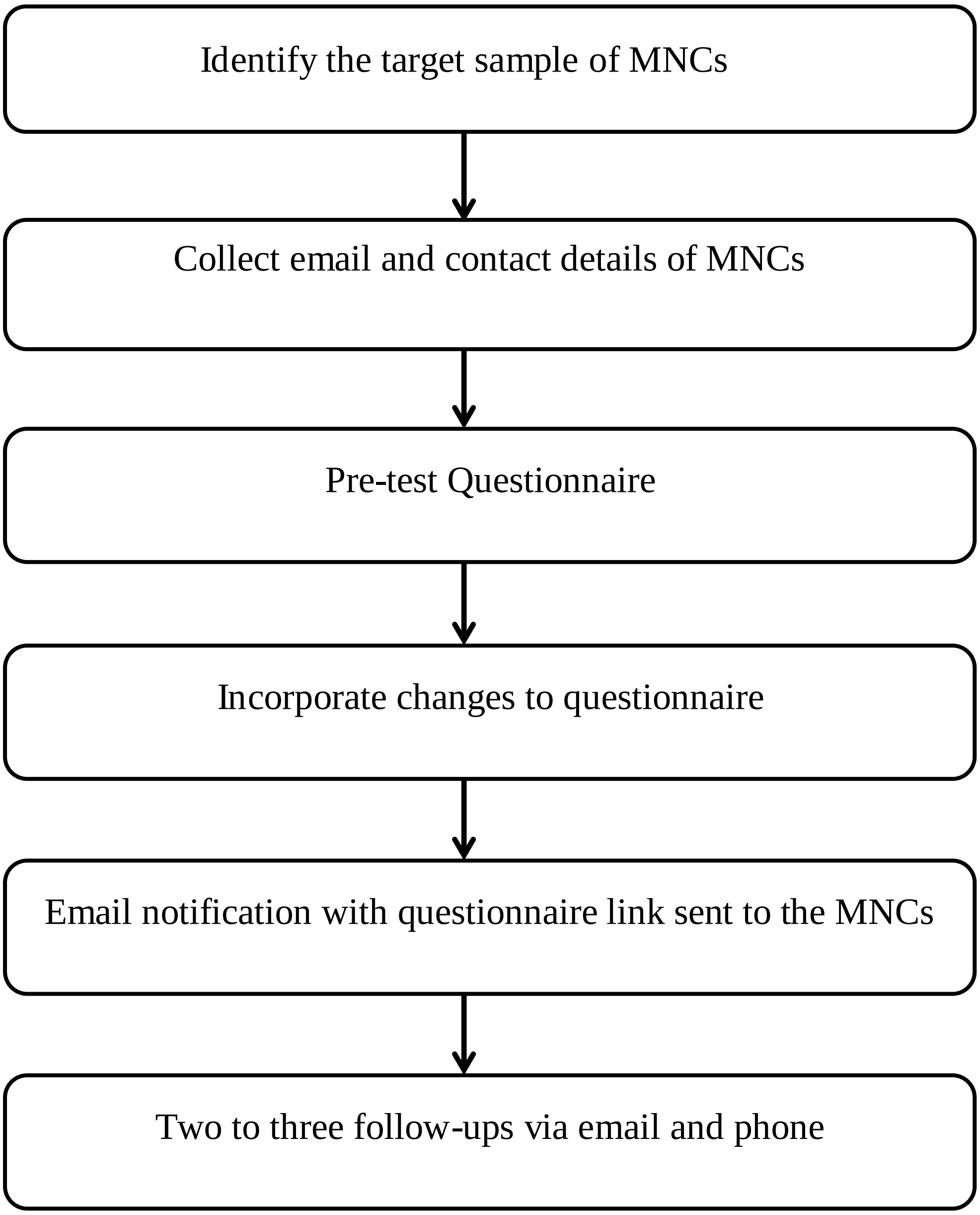
In a survey-based research, a population consists of all of the units (individuals, households, organisations) to which one desires to generalise survey results (De Vaus, 2013). It refers to the universe of units from which the sample is to be selected (Bryman & Bell, 2007). In this research, the population consists of MNCs offshoring R&D activities from all industries. The main reason for selecting all industries as the population of this study is that past studies have limited their samples to single industries and the study aimed to improve the external validity of this research by obtaining data from a broader population of firms operating in all industries.

For this study, a list of the top 1000 R&D investing MNCs from the UK has been taken from the database of Department for Business Innovation and Skills of UK. This list of 1000 MNCs would be the target for this study since most of them are offshoring R&D activities across their national borders. The majority of these MNCs are from Software and Computer Services (15%), and Pharmaceuticals and Biotechnology (13%). MNCs from Banking and Financial services were excluded from this study considering the difference in the nature and type of the offshored R&D projects and activities when compared to manufacturing and IT related services. In addition, the representatives of the financial sector in the list of top 1000 R&D investing MNCs from the UK are only 2.7 percent. The majority of MNCs from this list are focused on manufacturing and non-financial services. Hence the exclusion of the financial services from this study does not have major implications on the findings or the heterogeneity of the sample in terms of the industrial sectors.

Data Collection

At the initial stage of data collection, the target respondents were sent an email stating the nature and purpose of the study including all other relevant details. The respondents were also assured of completed data confidentiality with respect to their identities and also the organisations they represent. At the end of the email, the link to the web based questionnaire was sent. To improve the response rates, follow up calls were made and emails were sent to these respondents. The data collection process is demonstrated in Figure 10.

Figure 10: Data Collection Process



Following a data collection which started in January, 2014 and finished at the end of March, 2014 around 1000 MNCs were contacted. Responses were received from 142 respondents of which, 126 were found to be usable and the others were discarded as they were invalid or had incomplete data. Each respondent gave information about 2 offshored R&D projects (first about R&D projects offshored to foreign affiliates of the company, and the second about R&D projects offshored to non-integrated suppliers). So, in total detailed information from 252 offshored R&D projects were collected.

Questionnaire Development

The questionnaire has been designed to test the causal relationship between the dependent and independent variables from the conceptual models discussed in Chapter 2. The scales used in the questionnaire have been selected following an extensive literature review and hence are pre-existing scales and in some cases have undergone slight adaptations for this particular study. Most of the questions are based on a 5 point Likert scale with a few having fixed alternative and open ended questions as provided in Appendix A.

The instrument was pretested with managers from MNCs and experienced academics in the international business field. The MNCs selected for the pre-test were from sectors like Biotechnology, Chemicals, Telecommunication, Mining, Oil & Natural Gas, and Metallurgy. The questionnaires were administered to five respondents who were senior managers and also involved discussions with some of these senior managers. The questionnaires were administered via email in four of the cases following a telephone discussion with the respondent, while the fifth one was personally administered. The contents of the questionnaire were also reviewed by three academics who provided feedback to improve the questionnaire. The pre-test was conducted to determine whether the questions in the instrument had the required clarity and if the respondent had any difficulty comprehending the questions.

Following the pre-test, the questionnaire was modified to take into account some of the feedback received during the pre-test. The questionnaire had three main sections – i) focusing on the determinants of captive offshoring, ii) focusing on the determinants of offshore outsourcing, and iii) focusing on knowledge transfer. Appendix A has all the questions and items that were part of the instrument.

Ethical considerations

The questionnaire was accompanied by a covering letter that states the objectives of the study and also ensures complete confidentiality of the data. It also assured the respondents that the data would be used only for academic publications and reports while strictly maintaining the anonymity of the respondents and the organisation to which they belong. These steps ensure that the research is granted approval in accordance with the university's ethics policy. The respondents can also opt to receive a report with the findings once they participate in the survey.

Measures – Independent and Control Variables

The independent variables and control variables used in the study along with their scales (used in the questionnaire) can be found in Appendix A. They have been measured mostly using a five-point Likert scale and some of them via open ended and fixed alternative questions. For all Likert scale items, the item scores for a construct were summed up and divided by the number of items to arrive at the scores for the specific construct.

Dependent variable: For this thesis Rugman (2005) definition of the Triad as consisting of NAFTA, EU, and Asia (extended ASEAN). Despite some criticisms, Rugman's definition of the Triad regional boundaries provides a good foundation for further research on MNCs' R&D location choice decisions (Flores & Aguilera, 2007). Although the logic behind the Triad concept was used in the thesis, it was also realized that countries in each region of the triad regions are not homogenous. Therefore, the Asian countries were split into two clusters: India & China and the Emerging Asian Countries (Japan, Taiwan, Singapore and South Korea). Other clusters are USA, Canada & Australia, EU countries and Middle East, South

America, Africa & Russia. Therefore host countries for R&D offshoring were classified into regions along the lines that Rugman (2005) suggested, but excluded countries that are not homogenous with the cluster. The logic behind this is the inherited knowledge infrastructure and similarity of science and engineering education in these country clusters. Further, by excluding Mexico and including Australia into the NAFTA group and dividing Asian countries into two clusters, the heterogeneity was addressed. According to Field (2013), in order to have reliable results from multinomial logistic regression model, there should be at least 50 project data for each dependent variable. Since only 252 data were collected from the MNCs, the maximum number of dependant variable is only 5. While EU, USA, Canada & Australia, Japan, Taiwan, Singapore & South Korea, and China & India clusters were constructed based on the framework of Rugman (2005), the last cluster Middle East, South America, Africa & Russia which can be also named as others was constructed because of statistical restriction of the model.

Table 1 provides the profile of the respondent Multinational Corporations. The respondent MNCs are mostly from Pharmaceutical (15%), Software and Computer Services (13.5%), Chemicals (13.5%) and Biotechnology (10.3%) sectors which is also in accordance with the pattern shown by the target sample. The mean age of the respondent MNCs is 65 years and the mean number of employees is 22300 people.

Table 1: Characteristics of the sample

Description	***Percentage***	***Description***	***Percentage***
Industry – Sector		***MNC age***	
Pharmaceuticals	15.08	< 20 years	20.63
Chemicals	14.73	21 – 30 years	13.49
Electronics	13.49	31 – 40 years	11.90

Software and Computer Services	13.49	41 – 70 years	17.46
Biotechnology	10.32	71 – 100 years	16.67
Motor Vehicles	10.32	> 100 years	19.84
Aerospace and Defence	9.52	***Number of employees***	
Electrical Machinery	7.94	< 1000	14.29
Telecommunication	7.14	1000 – 5000	24.60
Food Products	4.76	5000 – 10000	12.70
Metallurgy/ Mining	4.76	10000 – 20000	19.84
Computers and Office machines	3.97	> 20000	28.57
Paper and Printing	3.97	***Number of R&D employees***	
Plastic and Rubber	3.97	< 100	17.46
Non-electrical machinery	3.17	100 – 250	20.63
Oil and Gas	3.17	250 – 1000	21.43
Ships and Boats	0.79	1000 - 5000	23.91
Textiles	0.79	> 5000	16.67
Host region/ country		**No.**	**Percentage**
USA, Canada & Australia USA Canada Australia		**61** 40 7 14	**24.21**
EU15 Austria Belgium Denmark Finland France Germany		**61** 1 5 2 1 7 15 6	**24.21**

Ireland	2	
Italy	4	
Netherlands	1	
Norway	4	
Spain	6	
Sweden	7	
Switzerland		
Japan, Korea, Singapore & Taiwan	**30**	**11.90**
Japan	11	
Korea	2	
Singapore	10	
Taiwan	7	
India & China	**66**	**26.19**
India	36	
China	30	
Middle East, South America, Africa & Russia	**33**	**13.09**
Argentina	2	
Brazil	7	
Colombia	1	
Israel	1	
Mexico	1	
Pakistan	1	
Saudi Arabia	2	
South Africa	4	
Turkey	3	
United Arab Emirates	4	
Russia	8	
Total	**252**	**100.0**

Descriptives

Appendix C provides the descriptives for the main variables which are used in the study.

The bivariate correlations between the dependent variable and independent variables are given in Table 2 below. Bivariate correlation has been done with Pearson's correlation and 2-tailed significance tests. All of the independent variables have a significant correlation with the location of offshored R&D projects, which suggests that all of the independent variables have an influence on the dependent variable. There is a high correlation between human capital, country risk and NIS. This suggests that the locations with high human capital and low country risk are likely to have a better national innovation system. On the other hand, the cost of the project is negatively correlated with human capital, country risk and NIS, which means that the locations with high human capital, low country risk and national innovation system are not suitable for projects that aim at cost saving. There is also a negative correlation between routineness of the project and human capital, country risk and national innovation system of the location. This could be attributed to the fact that human capital, country risk and national innovation system of the location are not important factors when the offshored project is routine. However, these factors are important when the offshored project is innovative, which can be seen from the high positive correlation between the innovativeness of the project and human capital, country risk and national innovation system. There is also higher correlation of cultural difference between host and home countries with the interactivity of the project. The more interactive the offshoring project, the more important the cultural similarities like the same language, similar mentality and similar business environment become. The other independent variables also have a significant correlation with one another, although they are not as high.

Table 2: Correlation Table

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.Location	1															
2.Human Capital	-.570**	1														
3.Country Risk	-.661**	.848**	1													
4.NIS	-.696**	.901**	.904**	1												
5.Gov. Policy	.544**	-.502**	-.527**	-.548**	1											
6.Cost	.717**	-.708**	-.773**	-.771**	.616**	1										
7.Cultural Difference	-.677**	.410**	.446**	.500**	-.264**	-.400**	1									
8.Experience	.366**	-.260**	-.354**	-.332**	.403**	.352**	-.224**	1								
9.Reputation	-.615**	.659**	.663**	.702**	-.488**	-.662**	.407**	-.185**	1							
10.Capability	-.431**	.477**	.426**	.440**	-.239**	-.459**	.324**	.079	.508**	1						
11.Speed	.473**	-.274**	-.420**	-.358**	.307**	.553**	-.268**	.189**	-.366**	-.361**	1					
12.Quality	-.386**	.521**	.508**	.579**	-.385**	-.509**	.189**	-.211**	.481**	.210**	-.142*	1				
13.Classification	.484**	-.769**	-.785**	-.763**	.411**	.710**	-.338**	.142*	-.643**	-.464**	.306**	-.455**	1			
14.Routineness	.576**	-.790**	-.767**	-.800**	.412**	.725**	-.403**	.151*	-.689**	-.455**	.364**	-.458**	.857**	1		
15.Interactivity	-.530**	.309**	.319**	.374**	-.169**	-.216**	.814**	-.134*	.267**	.240**	-.141*	.134*	-.215**	-.255**	1	
16.Innovativeness	-.583**	.841**	.829**	.844**	-.464**	-.763**	.409**	-.217**	.722**	.459**	-.350**	.518**	-.855**	-.896**	.277**	1

N = 252

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Reliability and Validity

*Common Method Bias***:** Given the fact that the study is single informant and dealing with perceptual measures, it becomes essential to validate the findings for a potential common method bias. To reduce the possibility of such a bias, the questionnaire was constructed with different response formats including Likert scale, open ended questions and fixed alternative questions. To further reduce the possibility of social desirability bias, the respondents were assured that the identity of the organisation as well as the respondent would not be revealed and would be kept anonymous; as a post-hoc analysis, Harman's one-factor test was performed with principal component analyses of all Likert type measurement items including both dependent and independent variables. Harman's test for the data gave around 20 factors with eigenvalues greater than 1 that together explained 79% of the variance. There was not a single factor that accounted for most of the variance i.e. more than half of the total variance (a single factor explains a maximum 25% of the total variance), which suggests that common method bias is not a potential problem.

Non-response bias: To assess for the potential presence of non-response bias with the data, a t-test (independent sample) was performed to check whether the non-respondent and respondent firm differed in terms of a few related parameters like their R&D investment, operating profit, sales and employees (Armstrong and Overton, 1977). The information pertaining to these figures was obtained from secondary data collected from company websites and other online information sources. The results from the t-test suggested that there were no significant differences ($p < 0.05$) between the respondent and non-respondent firms with respect to the chosen parameters, indicating that the data does not pose any problems when it comes to non-response bias.

It was mentioned before that the questionnaire was distributed to 941 MNCs and 126 responses were collected (the response rate is 13%). According to Field (2013), this response rate can be acceptable and is enough to represent the population if the distribution of industries in the whole sample and collected data are similar. By comparing the industrial distribution of 1000 R&D investing MNCs in Appendix C and industrial distribution of sample in table 1, it can be concluded that the response rate 13% is acceptable.

In order to minimize the retrospective bias i.e. any possibility of distorted data or memory loss the managers were asked to answer the questionnaire based on their experience of R&D offshoring in the last 5 years.

Reliability: Internal consistency of the items in the scales has been evaluated using Cronbach's alpha coefficient. The results of the reliability tests are provided in Table 3 for all the multi-item constructs used in this study. All of the coefficients are above 0.7, which is an indication that the scales are fairly reliable.

Table 3: Reliability Test – Cronbach's alpha (using SPSS)

Independent variable	**Cronbach's alpha**
Human Capital	0.801
Country Risk	0.808
National Innovation System	0.838
Cost	0.822
Cultural Difference	0.882
Experience	0.785
The degree of innovativeness of the offshored R&D activities	0.936
The degree of routineness of the offshored R&D activities	0.835

Factor Analysis

Exploratory Factor Analysis

Exploratory Factor Analysis (EFA) was performed on all the multi-item perceptual scales that are part of the instrument. A principal component analysis (PCA) was conducted on the 23 items with orthogonal rotation (varimax). The Kaiser-Meyer-Olkin (KMO) measure verified the sampling adequacy for the analysis as KMO = 0.894 and all KMO values for individual items were > 0.73, which is well above the acceptable limit of 0.5 (Field, 2009). Bartlett's test of sphericity of χ^2 (253) = 2791.048, $p < .001$, indicated that correlations between items were sufficiently large for PCA. An initial analysis was run to obtain eigenvalues for each component in the data. Six components had eigenvalues over Kaiser's criterion of 1 and in combination explained 79.63% of the variance. The scree plot was slightly ambiguous and showed inflexions that would justify retaining both components 4 and 6. The loadings are all greater than 0.5, which indicates that the items are all strongly related to the construct on to which they are loading. There are few cases with relatively higher cross loadings (HumanCapital_2, Risk_4, NIS_2 and Exp_2). However, these loadings are all less than the original loadings indicating that they are more closely related to the construct intended to be measured than the construct onto which they have cross loaded. Given the sample size, and the convergence of the scree plot and Kaiser's criterion on six components, this is the number of components that were retained in the final analyses.

Table 4: Rotated Component Matrix – EFA

Construct Name	Item Names	Human Capital	Country Risk	National Innovation System	Cultural Difference	Cost	Experience	Degree of innovativeness	Degree of routineness
Human Capital	HumanCapital_1	0.845							
	HumanCapital_2	0.885		0.502					
	HumanCapital_3	0.764							
Country Risk	Risk_1		0.641						
	Risk_2		0.681						
	Risk_3		0.791						
	Risk_4		0.635			-0.518			
	Risk_5		0.711						
National Innovation System	NIS_1			0.775					
	NIS_2	0.439		0.798					
	NIS_3			0.784					
	NIS_4			0.708					
Cultural Difference	Culture_1				0.738				
	Culture_2				0.721				
	Culture_3				0.922				
	Culture_4				0.895				
	Culture_5				0.858				
Cost	Cost_1					0.829			
	Cost_2					0.849			

	Cost_3					0.851			
Experience	Exp_1						0.838		
	Exp_2		0.485				0.663		
	Exp_3						0.866		
Degree of innovativeness	Deg_Inn_1							0.812	
	Deg_Inn_2							0.835	
	Deg_Inn_3							0.878	
	Deg_Inn_4							0.805	
Degree of routineness	Deg_Rou_1								0.856
	Deg_Rou_2								0.741
	Deg_Rou_3								0.778
	Deg_Rou_4								0.711

Extraction Method: Principal Component Analysis

Rotation Method: Varimax

Loadings below 0.4 have been suppressed

Confirmatory Factor Analyses

For performing Confirmatory Factor Analyses (CFA), SmartPLS statistical program has been used (with path weighting scheme). Partial Least Squares (PLS) method provides measures of composite reliability (for internal consistency), Cronbach's alpha and Average Variance Extracted (AVE) (for convergent validity) for the latent constructs as provided in Table 6. As per the PLS algorithm, bootstrapping was performed with 500 samples to arrive at the significance level from the t-statistic value. As shown in the table, the outer loadings on the construct are mostly ≥ 0.7 (Hulland, 1999) and are higher than the cross loadings on the constructs. Values for Composite Reliability (CR) of ≥ 0.7 (Bagozzi & Yi, 1988) and AVE ≥ 0.5 (Bagozzi & Yi, 1988) demonstrate the reliability and convergent validity of these perceptual scales.

Table 5: PLS output – Reliability and Convergent Validity

<table>
<tr><th>Variable</th><th>Item Name</th><th>Outer Loadings</th><th>AVE</th><th>CR</th><th>Cronbach's Alpha</th></tr>
<tr><td rowspan="3">Human Capital</td><td>HumanCapital_1</td><td>0.8436</td><td rowspan="3">0.7645</td><td rowspan="3">0.8503</td><td rowspan="3">0.8115</td></tr>
<tr><td>HumanCapital_2</td><td>0.8444</td></tr>
<tr><td>HumanCapital_3</td><td>0.8007</td></tr>
<tr><td rowspan="5">Country Risk</td><td>Risk_1</td><td>0.7612</td><td rowspan="5">0.6733</td><td rowspan="5">0.8444</td><td rowspan="5">0.8077</td></tr>
<tr><td>Risk_2</td><td>0.8976</td></tr>
<tr><td>Risk_3</td><td>0.8896</td></tr>
<tr><td>Risk_4</td><td>0.7139</td></tr>
<tr><td>Risk_5</td><td>0.8247</td></tr>
<tr><td rowspan="4">National Innovation System</td><td>NIS_1</td><td>0.8236</td><td rowspan="4">0.7407</td><td rowspan="4">0.8548</td><td rowspan="4">0.8374</td></tr>
<tr><td>NIS_2</td><td>0.8214</td></tr>
<tr><td>NIS_3</td><td>0.9005</td></tr>
<tr><td>NIS_4</td><td>0.8219</td></tr>
<tr><td rowspan="4">Cultural Difference</td><td>Culture_1</td><td>0.8737</td><td rowspan="4">0.884</td><td rowspan="4">0.9478</td><td rowspan="4">0.8815</td></tr>
<tr><td>Culture_2</td><td>0.902</td></tr>
<tr><td>Culture_3</td><td>0.8855</td></tr>
<tr><td>Culture_4</td><td>0.8787</td></tr>
</table>

	Culture_5	0.887			
Cost	Cost_1	0.8588	0.8197	0.8717	0.8263
	Cost_2	0.8555			
	Cost_3	0.8627			
Experience	Exp_1	0.7801	0.6275	0.7316	0.7642
	Exp_2	0.9304			
	Exp_3	0.6389			
Degree of innovativeness	Deg_Inn_1	0.9214	0.8397	0.9544	0.9358
	Deg_Inn_2	0.9611			
	Deg_Inn_3	0.9239			
	Deg_Inn_4	0.8557			
Degree of routineness	Deg_Rou_1	0.8723	0.6728	0.8913	0.8373
	Deg_Rou_2	0.7994			
	Deg_Rou_3	0.8495			
	Deg_Rou_4	0.7548			

The Fornell-Lacker criterion (Fornell & Larcker, 1981) has been used to establish discriminant validity for the construct. For assessing the discriminant validity of these constructs, Table 6 has been provided with the bivariate correlations and the square root of AVE as the diagonal element. If the correlations for the specific construct with other constructs are less than the diagonal element (which indicates the construct's correlation with its own items), then it indicates discriminant validity of the construct. In addition other criteria could be used as given below:

- SQRT (AVE) is higher than the average of the correlation of the construct with the other constructs (Cool, Dierickx, & Jemison, 1989). This condition is satisfied with the data.
- Indicator loadings should be highest on the construct (Chin, 1998) that it measures when compared to its loading on the other constructs (cross loading). This condition is also satisfied for the data.

Table 6: Discriminant Validity

	Cost	Country Risk	Cultural Difference	Experience	Human Capital	National Innovation System	Degree of innovativeness	Degree of routineness
Cost	**0.9054**	0	0	0	0	0	0	0
Country Risk	-0.7788	**0.8205**	0	0	0	0	0	0
Cultural Difference	-0.4211	0.4698	**0.9402**	0	0	0	0	0
Experience	0.4028	-0.3964	-0.2631	**0.7921**	0	0	0	0
Human Capital	-0.6965	0.5453	0.4429	-0.3	**0.8744**	0	0	0
National Innovation System	-0.5627	0.6143	0.4866	-0.3846	0.7924	**0.8606**	0	0
Degree of innovativeness	-0.6839	0.6860	0.4711	-0.2634	0.6285	0.6420	**0.9164**	0
Degree of routineness	0.6350	-0.5566	-0.3447	0.2404	-0.6003	-0.5452	-0.6244	**0.8202**

CHAPTER 5 - DATA ANALYSIS

Overview of the analysis

The models outlined in Chapter 3 have been analysed using two methods i) Multinomial Logistic Regression and ii) Partial Least Squares (PLS) path modelling; the individual models are tested initially to confirm or reject the proposed hypothesis. Following this, the integrated model has been assessed to understand the inter-linkages between the different groups of predictor variables.

PLS path modelling was introduced by Wold (1974) for analysing high dimensional data in a low structure environment and has undergone various extensions and modifications. In contrast to covariance based Structural Equation Modelling, PLS path modelling is based on variance based techniques (Henseler, Ringle, & Sinkovics, 2009). In the last few years, PLS path modelling has been prevalent in marketing research (Henseler et al., 2009), in addition to strategic management (Hulland, 1999) and other related fields. In fact, a leading international journal in strategic management Long Range Planning had a special issue in 2012 devoted to PLS modelling in strategic management which indicates its growing importance. One of the advantages of the PLS path modelling over Structural Equation Modelling is that it is not rigid when it comes to the assumptions with respect to multivariate normality (Hair, Sarstedt, Ringle, & Mena, 2012). Further, the other advantage of PLS path modelling is the fact that it does not impose stringent restrictions as in Structural Equation Modelling on smaller samples and complex models, which suits this particular study. Further, it can incorporate both reflective and formative scales compared to Structural Equation Modelling which is very restrictive when it comes to formative scales. PLS path modelling is more predictive in nature compared to Structural Equation Modelling, which is more confirmatory. It also works well with nominal, ordinal, interval and ratio scaled data. PLS modelling estimates latent variable scores as linear combinations of their variables or indicators (Hair et al., 2012). All manifest variables are also given weights and none of them have equal weights. Manifest variables with a weak relationship with the construct and other manifest variables for the construct are given lesser weights.

However, the disadvantages of PLS path modelling are with respect to the absence of a global optimization criterion which implies a lack of good model fit (Hair et al., 2012). Although there are measures like GoF index and R^2, several questions are posed on the effectiveness of these measures and how stringent they are (Hulland, 1999). Another concern is the fact that the parameter estimates are not very optimal in terms of bias and consistency (Hair et al., 2012). This bias is greater when it comes to more complex models. The strength and weakness with PLS path modelling should be well understood before using it. Further, PLS path modelling does not provide significance levels and a bootstrap or jack-knife procedure has to be run to get the t-statistic values which could then be used to check if the estimates are significant. For these reasons, this study focuses on Multinomial Logistic Regression results, but also provides PLS path modelling output to further substantiate the findings from the study in terms of validating both measurement and structural aspects of the model. Also, in order to confirm that there is a significant difference between the degree of innovativeness and routineness of the R&D activities offshored to foreign affiliates of the firm and to non-integrated suppliers one-way and two-way ANOVA methods were used.

For the PLS analysis, the results from both the measurement and structural model have been presented. For the measurement model, the tables represent the extent to which the individual items load on to the construct they intend to capture and the average variance extracted (AVE), which indicates convergent validity for the construct with its items. In addition measurement model analysis also provided the reliability of the scales with composite reliability (CR) and Cronbach's alpha. The structural model results are presented in terms of path coefficients and their significance along with R^2 which indicates the explanatory power of the model. R^2 values of 0.67, 0.33 and 0.19 are indicative of substantial, moderate and weak PLS models (Chin, 1998). For performing PLS path modelling, SmartPLS has been used to test the measurement and structural model. Contrary to Structural Equation Modelling, in the PLS path model the measurement and structural models get assessed simultaneously. Hence for each model that has been analysed, both the measurement and structural models are assessed.

In terms of presentation of the results of Multinomial Logistic Regression, one-way and factorial ANOVA, the tables provided in the subsequent sections include regression coefficients, standard errors, significance of these coefficients and graphs. The following sections detail the analysis of the individual models as explained above followed by the analyses of the integrated model and ANOVA method.

Model 1 – Country level determinants

This section deals with the analyses of the effects of the country level factors on the location choice of R&D offshoring companies tested using multinomial logistic regression and PLS modelling.

Multinomial Logistic Regression

The country level determinants analysed in this section are shown in Figure 9. The control variables such as company size, company age and R&D size of the company have been subjected to logarithmic transformation to address the skewness of the associated data. The type of offshoring is a dichotomous control variable that indicates if the project was offshored to foreign affiliates of the company or to the external vendor. The results of multinomial logistic regression on location choice of R&D offshoring companies have been presented in Table 7. The control variables in the model have been italicised in the table. Also, the marginal effects are shown in Table 8.

Table 7: Results for multinomial logistic model 1 (reference group: EU15)

Model with only Control Variables (1A)								
Variable	**USA, Canada & Australia**	**S.E.**	**Japan, South Korea, Taiwan & Singapore**	**S.E.**	**India & China**	**S.E.**	**Middle East, S.America & Russia**	**S.E.**
Intercept	-1.323	1.243	0.720	1.423	1.339	1.323	-0.078	1.480
Log of Company Size	0.136	.361	-0.373	.428	0.171	.396	0.161	.441
Log of R&D Size	0.081	.351	-0.007	.446	-0.191	.393	-0.258	.435
Log of Company Age	0.137	.509	-0.073	.648	-0.145	.573	0.324	.638
(Type of offshoring = 0)	0.440	.421	0.141	.502	-3.381***	.544	-2.058***	.494
(Type of offshoring = 1)	0[a]		0[a]		0[a]		0[a]	

N = 252; Log likelihood: - 338.161; χ^2 (16) = 110.560; Prob. $\chi^2 \leq 0.001$; pseudo R^2 = 0.141
a. This parameter is set to zero because it is redundant.
*** $p \leq 0.01$; ** $p \leq 0.05$; * $p \leq 0.1$

Model with only Independent Variables (1B)

Variable	USA, Canada & Australia	S.E.	Japan, South Korea, Taiwan & Singapore	S.E.	India & China	S.E.	Middle East, S.America & Russia	S.E.
Intercept	-20.202***	4.552	-7.971***	2.717	-10.322***	3.492	-3.296*	3.299
Human Capital	0.524	0.718	1.978***	.686	1.995**	.795	1.533*	.806
Country Risk	-1.175*	0.734	0.299	.698	-1.773*	1.016	-1.230	.992
NIS	2.457***	0.950	-1.115*	.796	-0.662	1.017	-0.857	1.030
Cost	-0.251	0.466	1.607***	0.391	3.729***	.602	2.347***	.535
Cultural Difference	3.633***	0.692	-0.605*	0.351	-0.921**	.408	-1.367***	.450

N = 252; Log likelihood: - 188.506; χ^2 (20) = 409.670; Prob. $\chi^2 \leq 0.001$; pseudo R^2 = 0.521
*** $p \leq 0.01$; ** $p \leq 0.05$; * $p \leq 0.1$

Model with Control and Independent Variables (1C)

Variable	USA, Canada & Australia	S.E.	Japan, South Korea, Taiwan & Singapore	S.E.	India & China	S.E.	Middle East, S.America & Russia	S.E.
Intercept	-23.659***	5.369	-7.837**	3.196	-8.385**	3.895	-3.368*	3.748
Log of Company Size	0.459	.633	-0.365	.559	-0.626	.646	-0.453	.642
Log of R&D Size	0.084	.644	0.138	.574	0.611	.678	0.501	.680
Log of Company Age	0.465	.927	0.074	.770	0.851	.960	1.210	.961
Human Capital	1.723	.759	2.080***	.711	2.059**	.817	1.590*	.832
Country Risk	0.625*0	.841	.237	.710	-1.799*	1.071	-1.282*	1.044
NIS	2.499**	1.020	-1.173*	.824	-1.022*	1.070	-1.235*	1.095
Cost	-0.087	.520	1.731***	.411	3.330***	.618	2.180***	.556
Cultural Difference	3.758***	.726	-0.684*	.373	-0.817**	.424	-1.280***	.464
(Type of offshoring = 0)	0.904	.775	0.899	.620	-1.218	.773	-0.318	.729
(Type of offshoring = 1)	0[a]		0[a]		0[a]		0[a]	

N = 252; Log likelihood: - 180.569; χ^2 (36) = 425.562; Prob. $\chi^2 \leq 0.005$; pseudo R^2 = 0.541

*** $p \leq 0.01$; ** $p \leq 0.05$; * $p \leq 0.1$

a. This parameter is set to zero because it is redundant.

Table 8: Marginal effects

Variable name	EU15	USA, Canada & Australia	Japan, South Korea, Taiwan & Singapore	India & China	Middle East, S.America, & Russia
Log of Company Size	0.1029	0.0056	-0.0441	-0.0329	-0.0315
Log of Company Age	-0.1251	0.0019	-0.0469	0.0474	0.1226
Human Capital	-0.4815***	0.0018*	0.3147*	0.0871*	0.0814
Country Risk	0.1164*	0.1278*	0.1345	-0.1208*	-0.1298*
NIS	0.2562*	0.2752*	-0.1754	-0.0377*	-0.0877*
Cost	-0.5172***	-0.0093***	0.1988*	0.1808***	0.1469*
Cultural Difference	0.0350*	0.1950*	-0.0834*	-0.0338*	-0.1127*
Type of offshoring [a]	0.0584	-.0065	-0.2123*	0.1074	0.0530

N = 252; *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$

Marginal effects are evaluated at the mean values of the explanatory variables.

[a] dy/dx is for discrete change of dummy variable from 0 to1.

Multinomial Logistic Regression –Results

The analyses were based on the sets of models (1A, 1B and 1C) which tested the effects of country level factors on the location choice decision of R&D offshoring companies. These models (1A, 1B and 1C) analysed the effects of the control variables, independent variables and the combined effects of both control and independent variables on location choice of MNCs respectively. Model 1C represents the overall results after applying the control variables. The pseudo R^2 values for models 1A, 1B and 1C are 0.141, 0.521 and 0.541 respectively. This indicates that adding the independent variables improved the explanatory power of the models in terms of R^2. Further, Chi-square statistics suggest that all models are significant (model 1A at $p \leq 0.005$; models 1B and 1C at $p \leq 0.001$). The Chi-square significance levels also improved in the models with the introduction of the independent variables. The analyses included analysis of the multinational companies' offshoring location decisions between 5 country groups. The location choice decisions between regions for offshoring of R&D projects are demonstrated in Table 7. The coefficients indicate the utility of selecting one group of countries compared to the EU15 region. Positive coefficient of the independent variable is an indication of increasing likelihood of that group of countries being chosen as an R&D offshoring location, and a negative sign indicates that the probability of the EU15 region being selected is more than the other regions.

Hypothesis 2 related to the effect of human capital on the location decision of R&D offshoring and received important support in full model 1C. The β-coefficients associated with the USA, Canada & Australia (1.723, $p < 0.1$), Japan, South Korea, Taiwan & Singapore (2.080, $p < 0.01$), the Middle East, South America, Africa & Russia (1.590, $p < 0.1$), India and China (2.059, $p < 0.05$) are significant and positive. The findings mean that, as the necessity for qualified R&D personnel grows, these countries become more advantageous compared to EU15, especially Japan, South Korea, Taiwan and Singapore. The marginal analyses results shown in Table 8 also maintain the hypothesis. As these group of countries supply large human capital, the probability of a new R&D project offshored to Japan, South Korea, Taiwan & Singapore (31.5 %), India & China (8.7%), and the USA, Canada & Australia (0.2 %) increases, while the probability of the same R&D project being offshored to the EU15 region decreases by 48.1 per cent. The marginal effect of the Middle East, South America, Africa and Russia regions was not statistically significant, but overall Hypothesis 2 has been supported, confirming that human capital is the major determinant of the location choice decision for R&D offshoring companies.

Hypothesis 4 relating to the effect of country risk on the location decision of R&D offshoring also received important support. The more important the country risk factor was for R&D offshoring companies, the more likely the USA, Canada & Australia (0.625, $p < 0.1$) would be selected as R&D offshoring locations, whereas the probability of India & China (1,799, $p < 0.1$), and Middle East, South America, Africa & Russia (1.282, $p < 0.1$) being selected compared to the EU15 decreases. The coefficient of Japan, South Korea, Taiwan & Singapore on country risk factor is positive, but not significant. The results of marginal effects shown in Table 8 indicate that if country risk is a significant determinant then,the probability of being chosen as an offshore location rises for the USA, Canada & Australia (11.6 %) and EU15 region (12.8 %), while the probability for India & China and the Middle East, South America, Africa and Russia region decreases by 12.1 % and 12.9 % respectively. These findings show strong support for Hypothesis 4.

The National Innovation System related hypothesis also received significant support. While the β-coefficients associated with the USA, Canada & Australia (2.499, $p < 0.05$) are significant and positive, the coefficients of Japan, South Korea, Taiwan & Singapore (-1.171, $p < 0.1$), the Middle East, South America, Africa & Russia (-1.235, $p < 0.1$), India and China (-1.022, $p < 0.1$) are all negative and significant. The results of marginal effects shown in Table 8 indicate that if a National Innovation System is an important determinant of location choice decision, the probability of being chosen as an offshore location increases for the USA, Canada & Australia (27.5 %) and the EU15 region (25.6 %), while the probability of India & China and the Middle East, South America, Africa and Russia region decreases by 3.8 % and 8.8 % respectively. Overall, the findings confirm Hypothesis 3.

The β-coefficients on "cost" are negative and significant for Japan, South Korea, Taiwan & Singapore (- 1.731, $p < 0.01$), the Middle East, South America, Africa & Russia (- 2.180, $p < 0.01$), India and China (- 3.330, $p < 0.01$), and negative for the USA, Canada & Australia ($\beta = - 0.087$, $p > 0.1$), but not significant. These findings support the hypothesis that as the cost of doing R&D projects becomes important in the location decision, the greater the probability that Multinational Corporations will offshore R&D activities to Japan, South Korea, Taiwan, Singapore, India, China, the Middle East, South America, Africa and Russia. The results of the marginal effects shown in Table 8 also support Hypothesis 1. Significant and positive β-coefficients of Japan, South Korea, Taiwan & Singapore, India & China, and the Middle East, South America, Africa & Russia regions indicate that when the cost of doing R&D projects is an important driver of R&D offshoring, the probability of offshoring to these countries increases, and the probability of the USA, Canada & Australia and EU15 regions being selected as offshore locations decreases.

Turning to cultural distance between home country and host country, the β-coefficients associated with Japan, South Korea, Taiwan & Singapore (0.684, $p < 0.1$), the Middle East, South America, Africa & Russia (- 1.280, $p < 0.01$), India and China (- 0.817, $p < 0.05$) are all negative and significant. However, the coefficient of the USA, Canada & Australia (β = 3.758, $p < 0.01$) region is positive and significant. These findings support Hypothesis 5 which supposes that the lesser the culture difference between home and host country, the greater the likelihood that the company will choose that region, since the home country for all R&D projects in my research is the United Kingdom. Positive and significant marginal effect coefficients of Japan, South Korea, Taiwan & Singapore, India & China, and the Middle East, South America, Africa & Russia regions indicate that when cultural difference is an important determinant of R&D projects, the probability of these countries being selected as an R&D offshoring location decreases, whereas the probability of the USA, Canada & Australia and EU15 regions being selected increases.

Regarding the control variables, R&D size and age of the company have positive effects on location choice decision; however, the effects are not statistically significant. The β-coefficients on “size of company” are negative for Japan, South Korea, Taiwan & Singapore (- 0.365, $p > 0.1$), Middle East, South America, Africa & Russia (- 0.453, $p > 0.1$), and India and China (- 0.626, $p > 0.1$), and positive for the USA, Canada & Australia (0.459, $p > 0.1$), but none are significant. Analyses on type of offshoring indicate that MNCs prefer to offshore R&D activities to foreign affiliates in the USA, Canada & Australia (0.907, $p > 0.1$) and in Japan, South Korea, Taiwan & Singapore (0.899, $p > 0.1$). Whereas, India and China (- 1.218, $p > 0.1$), and the Middle East, South America, Africa & Russia (- 0.318, $p > 0.1$) are selected as locations for offshore outsourcing. However, the results are not statistically significant.

PLS Path Modelling

The results from the analysis of the outer model have been presented in Table 9, where the outer loadings of the manifest variables or the items on the latent constructs have been provided. It also gives the Average Variance Extracted (AVE), Composite Reliability (CR) and Cronbach's alpha values for the latent constructs as estimated by Smart PLS. As shown in table 8, the indicator loadings on the construct are all ≥ 0.7 (Hulland, 1999) and significant. Additionally, the table also indicates that all CR ≥ 0.7 (Bagozzi & Yi, 1988); all AVE ≥ 0.5 (Bagozzi & Yi, 1988) and Cronbach's alpha values off all variables ≥ 0.7. These are all good indicators of reliability and convergent validity with respect to the measurement model. The same holds true for discriminant validity based on the Fornell-Lacker criterion (1981).

Table 9: PLS Measurement Model results – Model 1

Variable	Item Name	Outer Loadings	AVE	CR	Cronbach's Alpha
	HumanCapital_1	0.8436			
Human Capital	HumanCapital_2	0.8444	0.7645	0.8503	0.8115
	HumanCapital_3	0.8007			
	Risk_1	0.7612			
	Risk_2	0.8976			
Country Risk	Risk_3	0.8896	0.6733	0.8444	0.8077
	Risk_4	0.7139			
	Risk_5	0.8247			
National	NIS_1	0.8236	0.7407	0.8548	0.8374

Innovation System	NIS_2	0.8214			
	NIS_3	0.9005			
	NIS_4	0.8219			
Cultural Difference	Culture_1	0.8737	0.884	0.9478	0.8815
	Culture_2	0.902			
	Culture_3	0.8855			
	Culture_4	0.8787			
	Culture_5	0.887			
Cost	Cost_1	0.8588	0.8197	0.8717	0.8263
	Cost_2	0.8555			
	Cost_3	0.8627			

The primary criterion for the assessment of the structural model is R^2 (Hair et al., 2012) which in this case is 0.5512 (Table 11) which indicates that 55.12 % of the variance in the location choice decision of companies is explained by exogenous variables. The R^2 values indicate a moderately strong PLS model (Chin, 1998).

Table 10: PLS modelling with Location choice as the Endogenous variable – Model 1

Exogenous Variables	Path Coefficients	t-statistics (from bootstrapping)	R^2
Log of Company Size	0.0069	0.080	0.5512
Log of R&D Size	-0.0252	0.325	
Log of Company Age	0.0222	0.465	
Human Capital	0.2805	2.233**	
Country Risk	-0.2602	2.173**	
National Innovation System	-0.2542	1.681*	
Cost	0.3560	3.854***	
Cultural Difference	-0.4391	7.034***	
Type of offshoring	0.0781	0.852	

The path coefficients for the model are presented in Table 10. The control variables in the model have been italicised. Table 10 shows that PLS results also do not differ from the results of Multinomial Logistic Regression in Table 7.

It can be seen from Table 10 that the path coefficients for human capital and cost are positive and significant. The results of Multinomial Logistic Regression indicated that when human capital and cost are significant components of location choice decision for R&D offshoring, the likelihood of selecting Japan, South Korea, Taiwan & Singapore, India & China, and the Middle East, South America, Africa & Russia regions increases, while the likelihood of being chosen decreases for the USA, Canada & Australia and EU15 regions. For location variable EU15 and the USA, Canada & Australia regions were labelled as 0 and 1 respectively, whereas, Japan, South Korea, Taiwan & Singapore, India & China, and the Middle East, South America, Africa & Russia regions were labelled as 2, 3 and 4 accordingly. The results of the PLS modelling which demonstrated the positive relationship between human capital of the region and location choice, and the positive relationship between cost and location choice support the result of the MLR model, which confirms Hypotheses 1 and 2.

The results of PLS Modelling indicated that there are negative and statistically significant path coefficients for country risk, national innovation system and cultural difference variables. According to the results of the MLR model, when country risk of the location, national innovation system of the country and cultural difference between home and host country are significant components of location choice decision, the likelihood of being selected for the USA, Canada & Australia and EU15 regions increases, while the likelihood of being chosen for Japan, South Korea, Taiwan & Singapore, India & China, and the Middle East, South America, Africa & Russia regions decreases. The results of PLS Modelling indicate the negative relationship between country risk, national innovation system, cultural difference and location choice. Knowing the labelling of location variables, these outcomes also support the results of the Multinomial Logistic Regression, and confirm Hypotheses 3, 4 and 5. With regard to the control variables, the same results, as in the MLR model, have been observed, but none of them are statistically significant.

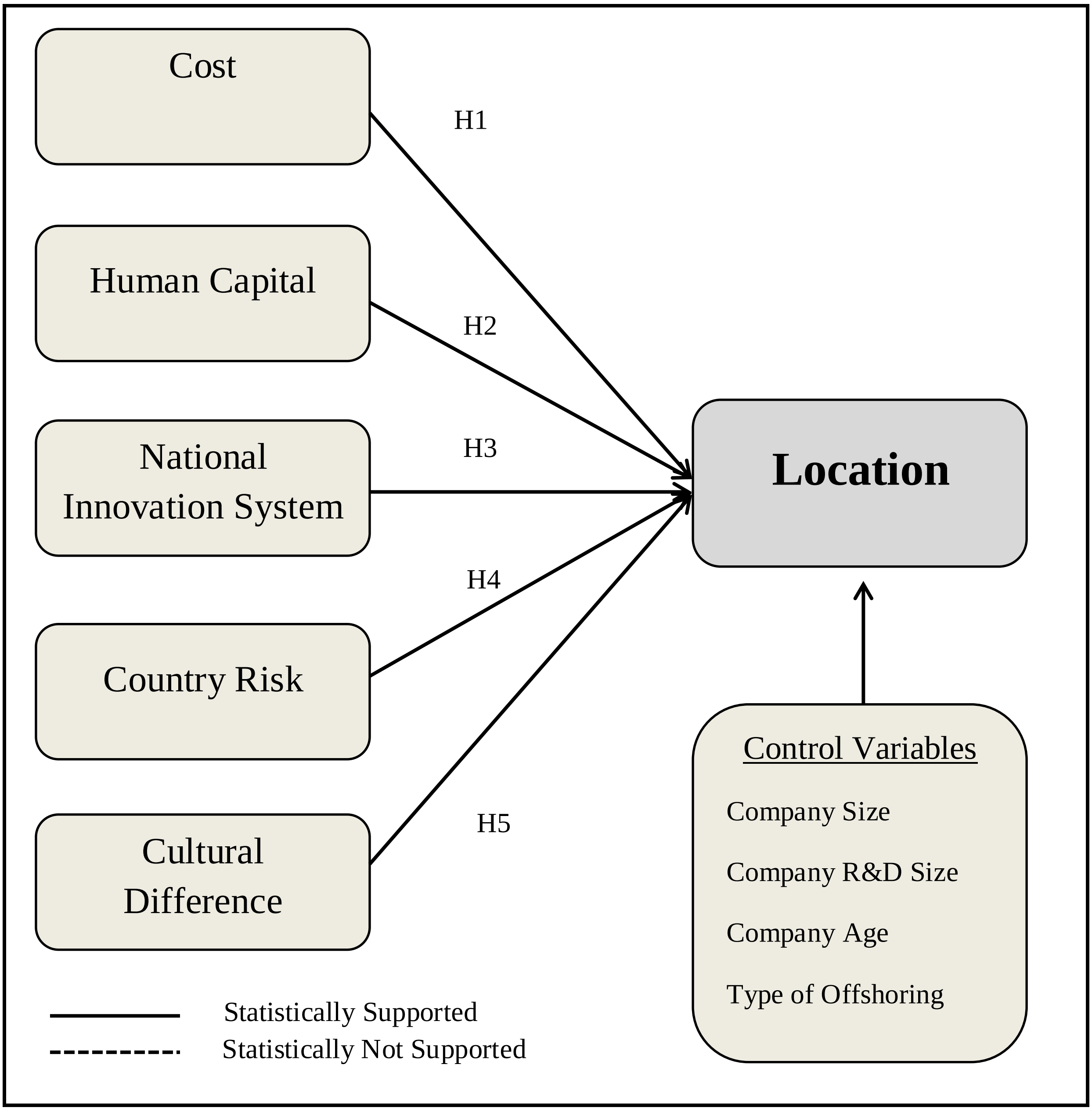


Figure 9: Conceptual Model 1
Adopted from Demirbag and Glaister (2010).

Model 2 – Company level determinants

This section deals with the analyses of the effects of the company level factors on the location choice of R&D offshoring companies tested using multinomial logistic regression and PLS modelling.

Multinomial Logistic Regression

The company level determinants analysed in this section are shown in Figure 10. The control variables such as company size, company age and R&D size of the company have been subjected to logarithmic transformation to address the skewness of the associated data. The type of the offshoring is a dichotomous control variable that indicates if the project was offshored to foreign affiliates of the company or to the external vendor. The results of multinomial logistic regression on location choice of R&D offshoring companies are presented in Table 11. The control variables in the model have been italicised in the table. The marginal effects are shown in Table 12.

Table 11: Results for multinomial logistic model 2 (reference group: EU15)

Model with only Control Variables (2A)								
Variable	**USA, Canada & Australia**	**S.E.**	**Japan, South Korea, Taiwan & Singapore**	**S.E.**	**India & China**	**S.E.**	**Middle East, S.America & Russia**	**S.E.**
Intercept	-1.323	1.243	0.720	1.423	1.339	1.323	-0.078	1.480
Log of Company Size	0.136	.361	-0.373	.428	0.171	.396	0.161	.441
Log of R&D Size	0.081	.351	-0.007	.446	-0.191	.393	-0.258	.435
Log of Company Age	0.137	.509	-0.073	.648	-0.145	.573	0.324	.638
(Type of offshoring = 0)	0.440	.421	0.141	.502	-3.381***	.544	-2.058***	.494
(Type of offshoring = 1)	0^a		0^a		0^a		0^a	

N = 252; Log likelihood: - 338.161; χ^2 (16) = 110.560; Prob. $\chi^2 \leq 0.001$; pseudo R^2 = 0.141
a. This parameter is set to zero because it is redundant.
*** $p \leq 0.01$; ** $p \leq 0.05$; * $p \leq 0.1$

Model with only Independent Variables (2B)

Variable	USA, Canada & Australia	S.E.	Japan, South Korea, Taiwan & Singapore	S.E.	India & China	S.E.	Middle East, S.America & Russia	S.E.
Intercept	-2.053	1.282	-2.605*	1.499	1.635	1.282	-0.211	1.553
Experience of the company	0.116	0.207	1.136**	0.321	1.765***	0.339	1.991***	0.398
Reputation of the host company	0.171	0.241	-0.572***	0.273	-1.596***	0.277	-1.468***	0.304
Capability of the host company	0.237	.188	0.046	.237	-0.707	0.228	-0.737	0.251

N = 252; Log likelihood: - 204.878; χ^2 (12) = 197.742; Prob. $\chi^2 \leq 0.001$; pseudo R^2 = 0.251
*** $p \leq 0.01$; ** $p \leq 0.05$; * $p \leq 0.1$

Model with Control and Independent Variables (2C)

Variable	USA, Canada & Australia	S.E.	Japan, South Korea, Taiwan & Singapore	S.E.	India & China	S.E.	Middle East, S.America & Russia	S.E.
Intercept	-3.325*	1.742	-1.837	2.026	2.008	2.088	-1.345	2.372
Log of Company Size	0.176	.363	-0.271	.453	0.315	.490	0.473	.533
Log of R&D Size	-0.037	.366	-0.475	.486	-0.507	.520	-0.754	.567
Log of Company Age	0.225	.522	0.019	.706	0.293	.745	0.733	.798
Experience of the company	0.154	.228	1.406***	.351	1.546***	.393	2.001***	.449
Reputation of the host company	0.132	.249	-0.553*	.289	-1.414***	.299	-1.345***	.324
Capability of the host company	0.243	.193	0.001	.244	-0.650	.244	-0.720	.261
(Type of offshoring = 0)	0.454	.448	0.868	.564	-2.237***	.635	-0.862	.612
(Type of offshoring = 1)	0[a]		0[a]		0[a]		0[a]	

N = 252; Log likelihood: - 275.231; χ^2 (28) = 236.419; Prob. $\chi^2 \leq 0.001$; pseudo R^2 = 0.3

*** $p \leq 0.01$; ** $p \leq 0.05$; * $p \leq 0.1$

a. This parameter is set to zero because it is redundant.

Table 12: Marginal effects

Variable name	EU15	USA, Canada & Australia	Japan, South Korea, Taiwan & Singapore	India & China	Middle East, S.America, & Russia
Log of Company Size	-0.0342	0.0171	-0.0598	0.0346	0.0423
Log of Company Age	-0.0623	0.0088	-0.0270	0.0169	0.0636
Experience of the company	-0.2378***	-0.1432***	0.1056**	0.1309***	0.1445***
Reputation of the host company	0.1409***	0.1392***	-0.0179	-0.1583***	-0.1038***
Capability of the host company	0.0412	0.0905	0.0207	-0.0847*	-0.0678*
Type of offshoring [a]	-0.0725	-0.1556**	-0.1663***	0.3323***	0.0621

N = 252; *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$
Marginal effects are evaluated at the mean values of the explanatory variables.
[a] dy/dx is for discrete change of dummy variable from 0 to1.

Multinomial Logistic Regression –Results

The analyses were based on the sets of models (2A, 2B and 2C) which tested the effects of Firm level factors on the location choice decision of R&D offshoring companies. These models (2A, 2B and 2C) analysed the effects of the control variables, independent variables and the combined effects of both control and independent variables on the location choice of MNCs respectively. Model 1C represents the overall results after applying the control variables. The pseudo R^2 values for models 2A, 2B and 2C are 0.141, 0.251 and 0.3 respectively. This indicates that adding the independent variables improved the explanatory power of the models in terms of R^2. Further, Chi-square statistics suggest that all models are significant (model 2A at $p \leq 0.005$; models 2B and 2C at $p \leq 0.001$). The Chi-square significance levels also improved in the models with the introduction of the independent variables.

The location choice decisions between regions for offshoring of R&D projects are demonstrated in Table 11. The β-coefficients indicate the utility of selecting one group of countries compared to the EU15 region. Positive coefficient of the independent variable is the indication of the increasing likelihood that countries are chosen as an R&D offshoring location, and a negative sign indicates that the probability of the EU15 region being selected is more than that region.

Hypothesis 6 related to the effect of experience of the firm on location decision of R&D offshoring activities received important support in the full model 2C. The β-coefficients of Japan, South Korea, Taiwan & Singapore (1.406, $p < 0.01$), India and China (1.546, $p < 0.01$), and the Middle East, South America, Africa & Russia (2.001, $p < 0.01$) regions are all positive and significant. The β -coefficient of the USA, Canada & Australia region (1.723, $p > 0.1$) is also positive, but not significant. This finding means that, as the company becomes more experienced, these countries become more advantageous compared to EU15, especially the Middle East, South America, Africa & Russia. The marginal analyses results shown in Table 12 also maintain the hypothesis. As the experience of the company increases, the probability of a new R&D project offshored to Japan, South Korea, Taiwan & Singapore (10.56 %), India & China (13.09 %), and the Middle East, South America, Africa & Russia (14.45 %) increases, while the probability of the same R&D project offshored to the EU15 region decreases by 23.78 per cent. The marginal effect of the USA, Canada & Australia region was significant; however, the non-significance of the coefficient did not allow us to interpret the result. Nevertheless, these results support Hypothesis 6, confirming that experience of the company is a major determinant of location choice decision for R&D offshoring companies.

Hypothesis 7 about the reputation of the company also received significant support. The more important the reputation of the company in the location choice decision of R&D offshoring, the likelihood of Japan, South Korea, Taiwan & Singapore (- 0.553, $p < 0.1$), India and China (- 1.414, $p < 0.01$), and the Middle East, South America, Africa & Russia (- 1.345, $p < 0.01$) being selected as a location compared to the EU15 region decreases. The coefficient of the USA, Canada & Australia region on reputation of the company is positive, but not significant. The results of marginal effects shown in Table 12, indicate that if the reputation of the host company is a significant determinant influencing location choice decision of R&D offshoring, the probability of being chosen increases for the EU15 region (13.92 %), while for the India & China and the Middle East, South America, Africa and Russia region it decreases by 15.83 % and 10.38 % respectively. The marginal effect result for Japan, South Korea, Taiwan & Singapore is not significant. These findings show strong support towards Hypothesis 7.

The β-coefficients on "capability of the host company" are negative and not significant for India and China (- 0.650, $p < 0.01$), and the Middle East, South America, Africa & Russia (- 0.720, $p < 0.01$), and positive for the USA, Canada & Australia (- 0.087, $p > 0.1$), and Japan, South Korea, Taiwan & Singapore (0.001, $p > 0.1$), and neither are significant. These findings do not support the hypothesis that when the capability of the company is an important component of the R&D offshoring process, the probability of Multinational Corporations offshoring R&D activities to India, China, Middle East, South America, Africa and Russia is lower. The results of marginal effects shown in Table 12 also do not confirm Hypothesis 8.

Regarding the control variables, age of the company having positive effects on location choice decision and size of the R&D personnel shows negative effects on location choice; however, the effects are not statistically significant. The β-coefficients on "size of company" are positive for the USA, Canada & Australia (0.176, $p > 0.1$), India and China (0.315, $p > 0.1$), and the Middle East, South America, Africa & Russia (0.473, $p > 0.1$), and negative for Japan, South Korea, Taiwan & Singapore (- 0.271, $p > 0.1$), but none are significant. Analyses on type of offshoring indicate that MNCs prefer to offshore R&D activities to external vendors in India and China (- 2.237, $p < 0.01$), and the Middle East, South America, Africa & Russia (-0.862, $p > 0.1$). The results of both the 2A and 2C models are significant for the India & China region. However, the result of the 2C model is not significant for the Middle East, South America, Africa & Russia region, while it was significant in model 2A. Also, the analyses on type of offshoring revealed that MNCs prefer the USA, Canada & Australia ($\beta = 0.454$, $p > 0.1$) and Japan, South Korea, Taiwan & Singapore ($\beta = 0.868$, $p > 0.1$) regions for captive offshoring. However, the results are not statistically significant.

PLS Path Modelling

The results from the analysis of outer model are presented in Table 13, where the outer loadings of the manifest variables or the items on the latent constructs have been provided. It also gives the Average Variance Extracted (AVE), Composite Reliability (CR) and Cronbach's alpha values for the latent constructs as estimated by Smart PLS. It is shown in table 8 that the indicator loadings on the construct are all ≥ 0.7 (Hulland, 1999) and significant. Additionally, the table also indicates that all CR ≥ 0.7 (Bagozzi & Yi, 1988); all AVE ≥ 0.5 (Bagozzi & Yi, 1988) and Cronbach's alpha values off all variables ≥ 0.7. These are all good indicators of reliability and convergent validity with respect to the measurement model. The same holds true for discriminant validity based on the Fornell-Lacker criterion (1981).

Table 13: PLS Measurement Model results – Model 2

Variable	Item Name	Outer Loadings	AVE	CR	Cronbach's Alpha
Experience	Exp_1	0.7801	0.6275	0.7316	0.7642
	Exp_2	0.9304			
	Exp_3	0.6389			

The primary criterion for the assessment of the structural model is R^2 (Hair et al., 2012) which in this case is 0.3204 (Table 14) which indicates that 32.04 % of the variance in the location choice decision of companies is explained by exogenous variables. The R^2 values indicate a moderately strong PLS model (Chin, 1998).

Table 14: PLS modelling with Location choice as the Endogenous variable – Model 2

Exogenous Variables	**Path Coefficients**	**t-statistics (from bootstrapping)**	$\mathbf{R^2}$
Log of Company Size	-0.0184	0.1718	0.3204
Log of R&D Size	-0.0673	0.6171	
Log of Company Age	0.0261	0.3730	
Experience	0.2611	3.0306***	
Reputation of the host company	-0.3425	3.3105***	
Capability of the host company	-0.1814	1.9749	
Type of offshoring	0.2127	2.0814**	

The path coefficients for the model are presented in Table 14. The control variables in the model have been italicised. Table 14 shows that the PLS results also do not differ from the results of Multinomial Logistic Regression in Table 12.

It can be seen from Table 14 that the path coefficient for experience of the company is positive and significant. The results of Multinomial Logistic Regression indicated that the more experienced the firm offshoring R&D project, the greater the likelihood of Japan, South Korea, Taiwan & Singapore, India & China, and the Middle East, South America, Africa & Russia regions being selected as the R&D offshoring location. For location variable, EU15 and the USA, Canada & Australia regions were labelled as 0 and 1 respectively; whereas, Japan, South Korea, Taiwan & Singapore, India & China, and the Middle East, South America, Africa & Russia regions were labelled as 2, 3 and 4 accordingly. The results of PLS modelling which demonstrated the positive relationship between experience of the company and location choice support the result of the MLR model, which confirms Hypothesis 6.

The results of PLS Modelling indicated that there are negative and statistically significant path coefficients for reputation of the company variable. According to the results of the MLR model, when reputation of the company is a significant component of the location choice decision, the likelihood of being selected for the EU15 region increases, while the likelihood of being chosen for Japan, South Korea, Taiwan & Singapore, India & China, and the Middle East, South America, Africa & Russia regions decreases. The results of PLS Modelling indicate the negative relationship between reputation and location choice. Knowing the labelling of the location variable, these outcomes also agree with the results of the MLR model, and confirm Hypothesis 7. However, the results of PLS modelling do not support hypothesis 8 which hypothesizes that the lower the capability of the firm the lower the likelihood of emerging countries being selected as R&D offshoring locations. With regard to the control variables, there is a positive relationship between type of offshoring and location, which indicates that MNCs prefer the USA, Canada & Australia and EU15 regions for captive offshoring, while Japan, South Korea, Taiwan & Singapore, India & China, and the Middle East, South America, Africa & Russia regions are preferable locations for offshore outsourcing. PLS modelling shows the same results relating to size, R&D size and age of the company, as in the MLR model, have been observed, but none are statistically significant.

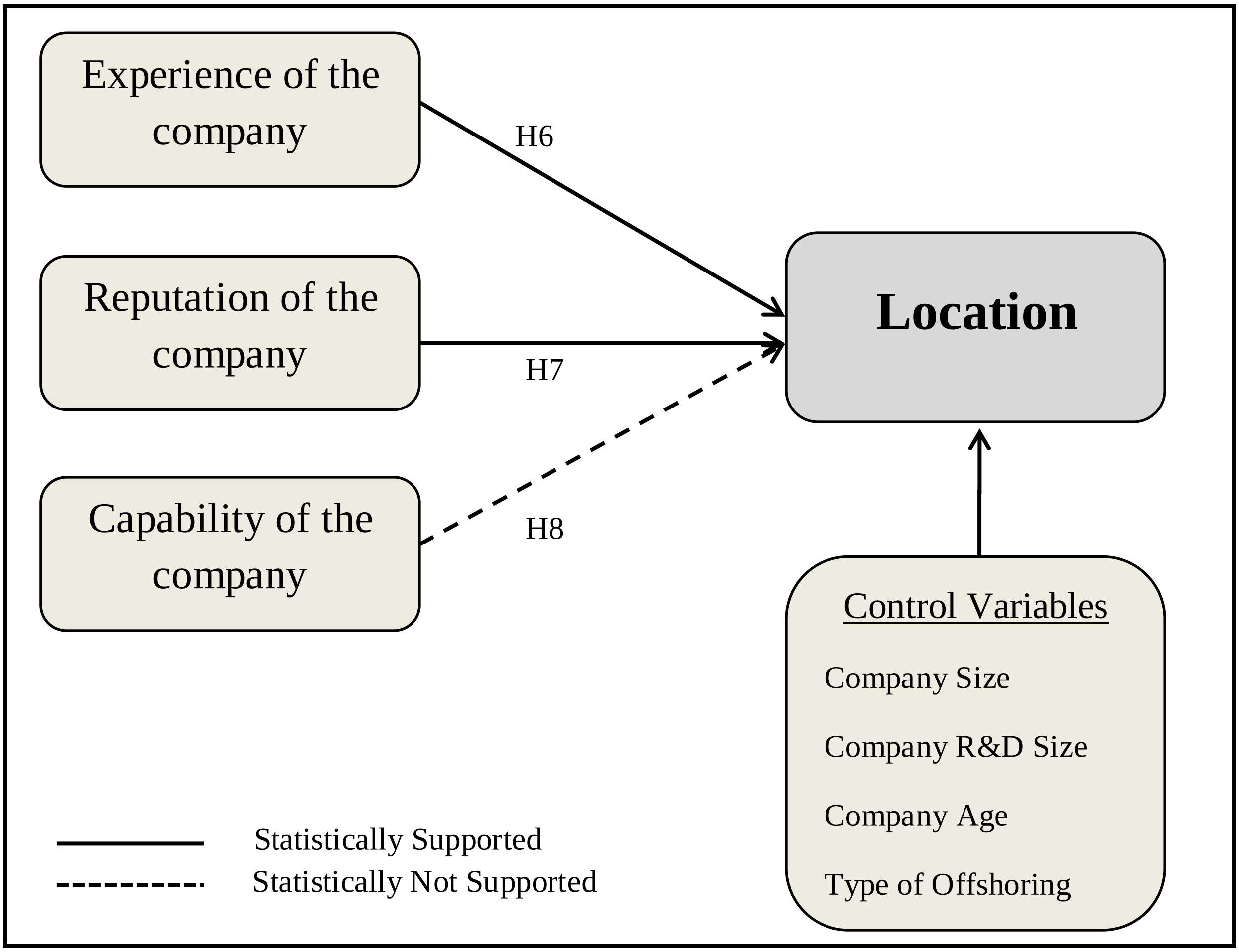


Figure 10: Conceptual Model 2
Adopted from Demirbag and Glaister (2010).

Model 3 – Project level determinants

This section deals with the analyses of the effects of the project level factors on the location choice of R&D offshoring companies tested using multinomial logistic regression and PLS modelling.

Multinomial Logistic Regression

The project level determinants analysed in this section are shown in Figure 12. The control variables such as company size, company age and R&D size of the company have been subjected to logarithmic transformation to address the skewness of the associated data. The type of the offshoring is a dichotomous control variable that indicates if the project was offshored to a foreign affiliate of the company or to the external vendor. The results of multinomial logistic regression on location choice of R&D offshoring companies are presented in Table 15. The control variables in the model have been italicised in the table. The marginal effects are shown in Table 16.

Table 15: Results for multinomial logistic model 3 (reference group: EU15)

Model with only Control Variables (3A)								
Variable	**USA, Canada & Australia**	**S.E.**	**Japan, South Korea, Taiwan & Singapore**	**S.E.**	**India & China**	**S.E.**	**Middle East, S.America & Russia**	**S.E.**
Intercept	-1.323	1.243	0.720	1.423	1.339	1.323	-0.078	1.480
Log of Company Size	0.136	.361	-0.373	.428	0.171	.396	0.161	.441
Log of R&D Size	0.081	.351	-0.007	.446	-0.191	.393	-0.258	.435
Log of Company Age	0.137	.509	-0.073	.648	-0.145	.573	0.324	.638
(Type of offshoring = 0)	0.440	.421	0.141	.502	-3.381***	.544	-2.058***	.494
(Type of offshoring = 1)	0^a		0^a		0^a		0^a	

N = 252; Log likelihood: - 338.161; χ^2 (16) = 110.560; Prob. $\chi^2 \leq 0.001$; pseudo R^2 = 0.141
a. This parameter is set to zero because it is redundant.
*** $p \leq 0.01$; ** $p \leq 0.05$; * $p \leq 0.1$

Model with only Independent Variables (3B)

Variable	USA, Canada & Australia	S.E.	Japan, South Korea, Taiwan & Singapore	S.E.	India & China	S.E.	Middle East, S.America & Russia	S.E.
Intercept	-9.286***	3.045	-5.413*	2.944	-11.994***	4.197	-0.174	3.054
Speed of the project	0.079	0.303	1.369***	0.302	3.763***	0.611	1.190***	0.318
Quality of the project	0.194	0.377	-0.911***	0.340	-0.975**	0.390	-0.771**	0.342
Routiness of the project	-0.178*	0.444	0.734	0.457	0.911*	0.539	0.724*	0.484
Interactivity of the project	1.665***	0.269	-0.079	0.225	-0.522**	0.266	-0.779***	0.255
Innovativeness of the project	0.126	0.481	0.034	0.533	-1.090*	0.565	-0.904*	0.530
(Classification of the project = 0)	1.530	1.666	4.315	1.793	5.520**	2.435	-15.041	0.000
(Classification of the project = 1)	2.127*	1.191	2.370	1.281	2.890*	1.552	1.966	1.267
(Classification of the project = 2)	0^a		0^a		0^a		0^a	

N = 252; Log likelihood: - 176.868; χ^2 (28) = 380.632; Prob. $\chi^2 \leq 0.001$; pseudo R^2 = 0.484
*** $p \leq 0.01$; ** $p \leq 0.05$; * $p \leq 0.1$

Model with Control and Independent Variables (3C)

Variable	USA, Canada & Australia	S.E.	Japan, South Korea, Taiwan & Singapore	S.E.	India & China	S.E.	Middle East, S.America & Russia	S.E.
Intercept	-12.506***	3.816	-4.422	3.421	-10.379**	4.772	0.104	3.644
Log of Company Size	0.647	.541	-0.625	.543	-0.434	.650	-0.053	.539
Log of R&D Size	-0.218	.540	-0.234	.571	0.103	.653	-0.105	.573
Log of Company Age	0.794	.742	0.520	.772	0.452	.871	0.808	.809
Speed of the project	0.182	.315	1.560***	.329	3.786***	.646	1.078***	.334
Quality of the project	0.138	.394	-0.880**	.354	-1.047**	.411	-0.792**	.348
Routiness of the project	-0.342*	.470	0.832	.499	0.675*	.607	0.595*	.522
Interactivity of the project	1.777***	.291	-0.194	.238	-0.434*	.283	-0.740***	.267

Innovativeness of the project	0.035*	.525	-0.228	.586	-0.861*	.624	-0.829*	.576
(Type of offshoring = 0)	0.431	.644	0.902	.668	-1.808**	.882	-0.807	.648
(Type of offshoring = 1)	0[a]		0[a]		0[a]		0[a]	
(Classification of the project = 1)	1.511	1.816	5.692	1.885	6.030**	2.557	-15.023	0.000
(Classification of the project = 2)	2.178	1.332	3.165	1.299	1.798	1.719	1.488	1.345
(Classification of the project = 3)	0[a]		0[a]		0[a]		0[a]	

N = 252; Log likelihood: - 190.155; χ^2 (44) = 406.572; Prob. $\chi^2 \leq 0.001$; pseudo $R^2 = 0.517$
*** $p \leq 0.01$; ** $p \leq 0.05$; * $p \leq 0.1$
a. This parameter is set to zero because it is redundant.

Table 16: Marginal effects

Variable name	EU15	USA, Canada & Australia	Japan, South Korea, Taiwan & Singapore	India & China	Middle East, S.America, & Russia
Log of Company Size	0.0447	0.0733	-0.1278	-0.0135	0.0233
Log of Company Age	0.0127	-0.1734	0.0356	0.0103	0.1146
Type of offshoring [a]	-0.0121	-0.0225	-0.2252**	.0776	0.1823*
Speed of the project	-0.0402**	-0.3405***	0.1842***	0.1526**	0.0438
Quality of the project	0.0277	0.1872***	-0.1158**	-0.0260	-0.0732
Routineness of the project	-0.0586**	-0.1242*	0.1143	0.0313*	0.0372*
Interactivity of the project	0.0491*	0.1095***	-0.0123	-0.0176*	-0.1286***
Innovativeness of the project	0.0189*	0.1177*	0.0194	-0.0331*	-0.1230*
Classification of the project	0.0490	0.4628**	-0.4380***	-0.0829	0.0091

N = 252; *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$
Marginal effects are evaluated at the mean values of the explanatory variables.
[a] dy/dx is for discrete change of dummy variable from 0 to1.

Multinomial Logistic Regression –Results

The analysis was based on the sets of models (3A, 3B and 3C) which tested the effects of project level factors on the location choice decision of R&D offshoring companies. These models (3A, 3B and 3C) analysed the effects of the control variables, independent variables and the combined effects of both control and independent variables on location choice of MNCs respectively. Model 3C represents the overall results after applying the control variables. The pseudo R^2 values for models 3A, 3B and 3C are 0.141, 0.484 and 0.517 respectively. This indicates that adding the independent variables improved the explanatory power of the models in terms of R^2. Further, Chi-square statistics suggest that all models are significant (model 3A at $p \leq 0.005$; models 3B and 3C at $p \leq 0.001$). The Chi-square significance levels were also improved in the models with the introduction of the independent variables.

The location choice decisions between regions for offshoring of R&D projects are demonstrated in Table 15. The β-coefficients indicate the utility of selecting one region compared to the EU15 region. Positive coefficient of the independent variable is the indication of increasing likelihood of that group of countries being selected as an R&D offshoring location, and a negative sign indicates that the probability of the EU15 region being selected is more than that group of countries.

Hypothesis 13 relating to the effect of the speed of the offshoring project on location choice decision received significant support in the full model 3C. The β-coefficients of Japan, South Korea, Taiwan & Singapore (1.560, $p < 0.01$), India and China (3.786, $p < 0.01$), and the Middle East, South America, Africa & Russia (1.078, $p < 0.01$) are all positive and significant. The coefficient of the USA, Canada & Australia region ($\beta = 1.723$, $p > 0.1$) is also positive; however, not statistically significant. These findings show that, the faster the offshored R&D project must be completed, the more advantageous these countries become compared to EU15, especially India & China. The marginal analyses results shown in Table 16 also support the hypothesis. When the speed of the R&D project completion is an important criterion in offshoring, the probability of a new R&D project offshored to Japan, South Korea, Taiwan & Singapore (18.42 %) and India & China (15.26 %) regions increases, while the probability of the same R&D project offshored to the USA, Canada & Australia and EU15 regions decreases by 34.05 and 4.02 per cent, respectively. The marginal effect of the Middle East, South America, Africa and Russia region was not statistically significant, but overall Hypothesis 13 has been supported, confirming that speed of the R&D project completion is the major determinant of location choice decision for R&D offshoring companies.

Hypothesis 14 relating to the effect of the quality of the completed R&D project on location choice also received significant support. The more important the quality of the completed R&D project for R&D offshoring companies, the likelihood of Japan, South Korea, Taiwan & Singapore (β = - 0.880, $p < 0.05$), India and China (β = - 1.047, $p < 0.05$), and the Middle East, South America, Africa & Russia (β = - 0.792, $p < 0.05$) being selected as R&D offshoring locations compared to the EU15 region decreases. The coefficient of the USA, Canada & Australia region on the quality of the project is positive, but not significant. The results of marginal effects shown in Table 16, indicate that if the quality of the completed R&D project is a significant determinant influencing location choice decision of R&D offshoring, the probability of being chosen as an offshore location increases for the USA, Canada & Australia (18.72 %), while the probability of the Japan, South Korea, Taiwan & Singapore region decreases by 11.58 per cent. The marginal effect of the EU15 region is positive, whereas, the marginal effects of India & China, and the Middle East, South America, Africa & Russia regions are negative; however, the results are not statistically significant. These findings show strong support for Hypothesis 14.

The routineness of the project related hypothesis also received significant support. While the coefficient associated with the USA, Canada & Australia (β = - 0.342, $p < 0.1$) region is significant and negative, the coefficients of India & China (β = 0.675, $p < 0.1$), and the Middle East, South America, Africa & Russia (β = 0.595, $p < 0.1$) regions are all positive and significant. The results of marginal effects shown in Table 16, indicate that the more routine the offshoring R&D project, the likelihood of being selected as an offshore location decreases for the USA, Canada & Australia (5.86 %) and EU15 (12.42 %) regions, while the probability of India & China and the Middle East, South America, Africa and Russia regions being selected increases by 3.13 % and 3.72 % respectively. Even the results of the Japan, South Korea, Taiwan & Singapore region are not statistically significant; overall, these findings confirm Hypothesis 10.

The β-coefficients on “interactivity of R&D project” are negative and significant for India and China (- 0.434, $p < 0.1$), and the Middle East, South America, Africa & Russia (- 0.740, $p < 0.01$) regions, and negative, but not significant for the Japan, South Korea, Taiwan & Singapore (β = - 0.194, $p > 0.1$) region. The β-coefficient of the USA, Canada & Australia (1.777, $p < 0.01$) region is positive and significant. These findings support the hypothesis that as the interactivity of the R&D project increases, Multinational Corporations are more likely to offshore R&D activities to regions which are culturally close to the home country. In my research the home country of all offshored R&D projects is the United Kingdom. So, it is the logical result that MNCs have chosen the USA, Canada, Australia and the EU15 region as an R&D offshoring location instead of India & China, and the Middle East, South America, Africa & Russia regions. The results of marginal effects shown in Table 16 also confirm Hypothesis 11. Positive and statistically significant β-coefficients of USA, Canada &

Australia and EU15 regions, and negative and significant β-coefficients of the Middle East, South America, Africa & Russia, and India and China regions indicate that when MNCs offshore interactive R&D projects from the UK, the probability of offshoring to the USA, Canada & Australia and EU15 regions increases, and the probability of India & China, and the Middle East, South America, Africa & Russia regions being selected as offshore locations decreases.

Turning to innovativeness of the offshored R&D project, the β-coefficients of India and China (- 0.861, $p < 0.1$), and the Middle East, South America, Africa & Russia (- 0.829, $p < 0.1$) regions are all negative and significant. However, the coefficient of the USA, Canada & Australia ($\beta = 0.035$, $p < 0.1$) region is positive and significant. These findings support Hypothesis 12 which supposes that the more innovative the offshoring R&D activities, the lower the likelihood of emerging and developing countries being selected by an MNC for offshore R&D activities. The results of marginal effects demonstrated in Table 16, imply that as the innovativeness of the R&D project increases, the likelihood of the USA, Canada & Australia and EU15 regions being chosen as an R&D offshoring location increases by 11.77 and 1.89 percent, respectively, while the likelihood of India & China, and the Middle East, South America, Africa & Russia regions being chosen decreases by 3.31 and 12.30 percent accordingly.

Hypothesis 9 relating to the classification of the offshored R&D project has not been supported. Hypothesis 9 stated that other things being equal, non-core R&D projects are more likely to be offshored to developing and emerging countries. However, the β-coefficients of dummy variable 1 (Core R&D projects vs. Non-core R&D projects) (- 15.023, $p > 0.1$) and dummy variable 2 (Essential R&D projects vs. Non-core R&D projects) (1.488, $p > 0.1$) for the Middle East, South America, Africa & Russia region were not statistically significant. While the β-coefficient of dummy variable 1 (6.030, $p < 0.5$) for India & China was significant, the β-coefficient of dummy variable 2 (1.798, $p > 0.1$) was not significant. So, the findings suppose that Hypothesis 9 was not supported.

Regarding the control variables, the age of the company having positive effects on location choice decision and size of the R&D personnel shows negative effects on location choice, except the India & China region; however, the effects are not statistically significant. The β-coefficient on “size of company” is positive for the USA, Canada & Australia (0.647, $p > 0.1$) region, and negative for Japan, South Korea, Taiwan & Singapore (- 0.625, $p > 0.1$), India & China (0.434, $p > 0.1$), and the Middle East, South America, Africa & Russia (- 0.053, $p > 0.1$) regions, but none are significant. Analyses on type of offshoring indicate that MNCs prefer to offshore R&D projects to external vendors in India & China ($\beta = - 1.808$, $p < 0.01$), and the Middle East, South America, Africa & Russia ($\beta = - 0.807$, $p > 0.1$). The results of both 3A and 3C models are significant for the India & China region. However, the result of the 3C model is not significant for the Middle East, South America, Africa & Russia region, while it was significant in model 3A. Also, the analyses on type of offshoring revealed that MNCs prefer the USA, Canada & Australia ($\beta = 0.431$, $p > 0.1$) and Japan, South Korea, Taiwan & Singapore ($\beta = 0.902$, $p > 0.1$) regions for captive offshoring. However, the results are not statistically significant.

PLS Path Modelling

The primary criterion for the assessment of the structural model is R^2 (Hair et al., 2012) which in this case is 0.5245 (Table 17) which indicates that 52.45 % of the variance in location choice decision of companies is explained by exogenous variables. The R^2 values indicate a moderately strong PLS model (Chin, 1998).

Table 17: PLS modelling with Location choice as the Endogenous variable – Model 3

Exogenous Variables	Path Coefficients	t-statistics (from bootstrapping)	R^2
Log of Company Size	-0.0764	0.7093	0.5245
Log of R&D Size	0.0188	0.1898	
Log of Company Age	0.0150	0.2172	
Type of offshoring	0.1664	1.6592*	
Speed of the project	0.2167	2.4876**	
Quality of the project	-0.1042	1.9781**	
Routineness of the project	0.2635	2.2870**	
Interactivity of the project	-0.3595	4.8385***	
Innovativeness of the project	-0.0991	3.4813***	
Classification of the project	-0.0974	0.6928	

The path coefficients for the model are presented in Table 17. The control variables in the model have been italicised. Table 17 shows that PLS results also do not differ from the results of Multinomial Logistic Regression in Table 17.

It can be seen from Table 17 that the path coefficient for speed of the completed R&D project and routineness of the project are positive and significant. The results of Multinomial Logistic Regression indicated that when speed and routineness of the project are significant components of the location choice decision for R&D offshoring, the likelihood of selecting Japan, South Korea, Taiwan & Singapore, India & China, and the Middle East, South America, Africa & Russia regions increases, while the likelihood of being chosen for R&D offshoring location decreases for the USA, Canada & Australia and EU15 regions. For location variable, EU15 and the USA, Canada & Australia regions were labelled as 0 and 1 respectively, whereas, Japan, South Korea, Taiwan & Singapore, India & China, and the Middle East, South America, Africa & Russia regions were labelled as 2, 3 and 4 accordingly. The results of PLS modelling which demonstrated the positive relationship between speed and routines of the project and location choice support the result of the MLR model, which confirms Hypotheses 10 and 13.

According to the results of the MLR model, when quality, interactivity and innovativeness of the R&D project are significant components of location choice decision, the likelihood of being selected for the USA, Canada & Australia and the EU15 regions increases, while the likelihood of being chosen for Japan, South Korea, Taiwan & Singapore, India & China, and the Middle East, South America, Africa & Russia regions decreases. The results of PLS Modelling indicate a negative relationship between quality, interactivity and innovativeness of the R&D project and location choice. Knowing the labelling of location variable, these outcomes also support the results of the MLR model, and confirm Hypotheses 11, 12 and 14.

The results of the MLR model in Table 15 indicated that hypothesis 9 which stated that other things being equal, non-core R&D projects are more likely to be offshored to developing and emerging countries was not supported. The same result has been taken from PLS path modelling. The path coefficient of classification of the R&D project variable was not statistically significant, which means that the relationship between the classification of the R&D project and location choice decision of R&D offshoring MNCs is not significant. These findings imply that hypothesis 9 was not supported.

With regard to the control variables, the PLS modelling implies that there is a positive relationship between type of offshoring and location, which indicates that MNCs prefer the USA, Canada & Australia and EU15 regions for captive offshoring, while Japan, South Korea, Taiwan & Singapore, India & China, and the Middle East, South America, Africa & Russia regions are preferable locations for offshore outsourcing. PLS modelling shows the same results relating to size, R&D size and age of the company, as in the MLR model, have been observed, but none of them are statistically significant.

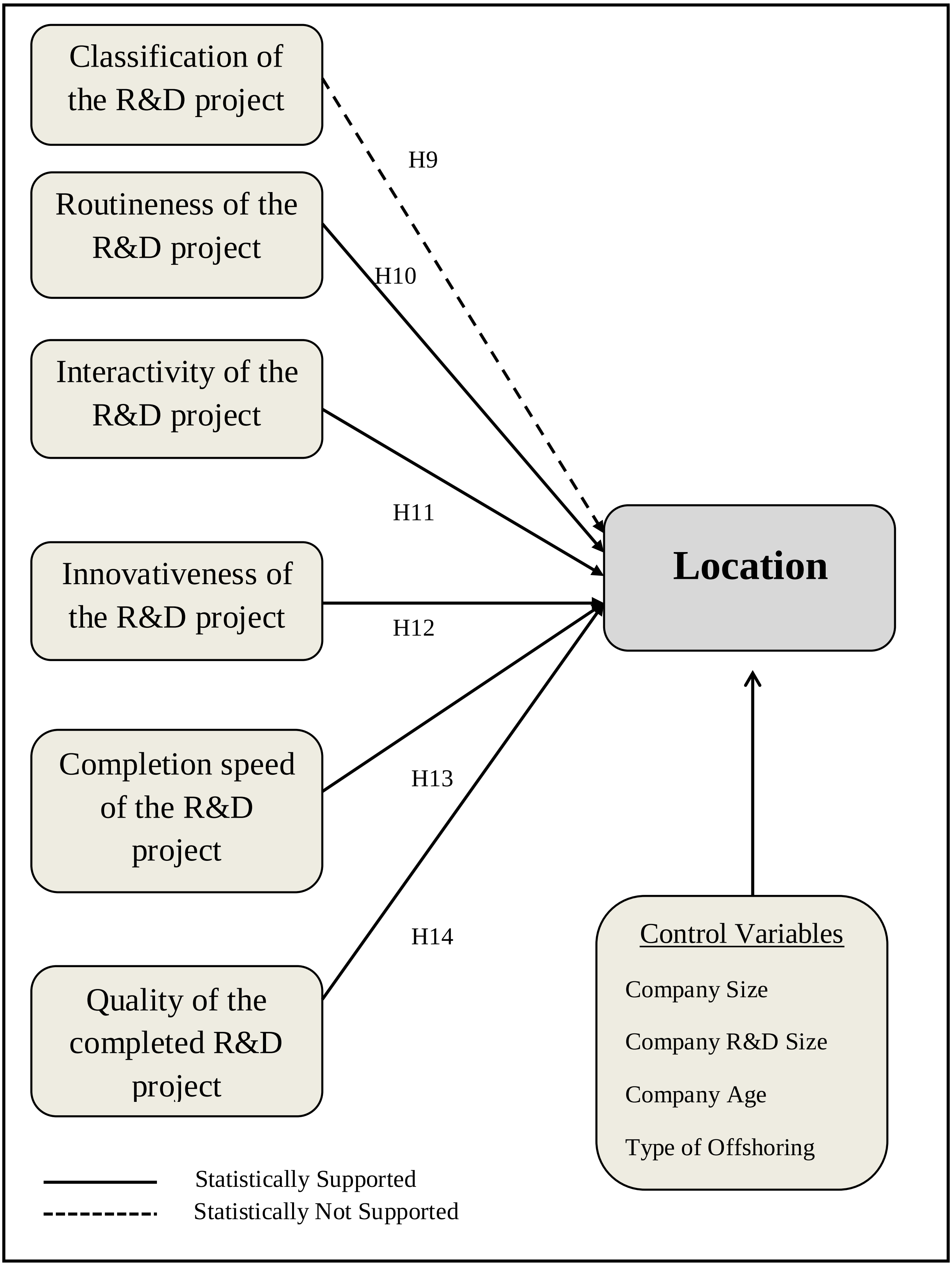


Figure 11: Conceptual Model 3
Adopted from Demirbag and Glaister (2010).

Model 4 – Integrated Model

This section deals with the analyses of the integrated model (country, company and project level determinants) using multinomial logistic regression and PLS modelling.

Multinomial Logistic Regression

The model analysed in this section has been depicted in Figure 12. All of the control and independent variables that have been used till now for the three individual models have been included in this integrated model. The results of the multinomial logistic regression are presented in Table 18. The control variables in the model have been italicised in the table.

Table 1: Results for multinomial logistic integrated model (reference group: EU15)

Model with only Control Variables (4A)								
Variable	**USA, Canada & Australia**	**S.E.**	**Japan, South Korea, Taiwan & Singapore**	**S.E.**	**India & China**	**S.E.**	**Middle East, S.America & Russia**	**S.E.**
Intercept	-1.323	1.243	0.720	1.423	1.339	1.323	-0.078	1.480
Log of Company Size	0.136	.361	-0.373	.428	0.171	.396	0.161	.441
Log of R&D Size	0.081	.351	-0.007	.446	-0.191	.393	-0.258	.435
Log of Company Age	0.137	.509	-0.073	.648	-0.145	.573	0.324	.638
(Type of offshoring = 0)	0.440	.421	0.141	.502	-3.381***	.544	-2.058***	.494
(Type of offshoring = 1)	0[a]		0[a]		0[a]		0[a]	
N = 252; Log likelihood: - 338.161; χ^2 (16) = 110.560; Prob. $\chi^2 \leq 0.005$; pseudo R^2 = 0.141 a. This parameter is set to zero because it is redundant. *** $p \leq 0.01$; ** $p \leq 0.05$; * $p \leq 0.1$								
Model with Control and Independent Variables (4B)								
Variable	**USA, Canada & Australia**	**S.E.**	**Japan, South Korea, Taiwan & Singapore**	**S.E.**	**India & China**	**S.E.**	**Middle East, S.America & Russia**	**S.E.**
Intercept	-23.659***	5.369	-7.837**	3.196	-8.385**	3.895	-3.368*	3.748
Log of Company	0.459	.633	-0.365	.559	-0.626	.646	-0.453	.642

Size								
Log of R&D Size	0.084	.644	0.138	.574	0.611	.678	0.501	.680
Log of Company Age	0.465	.927	0.074	.770	0.851	.960	1.210	.961
(Type of offshoring = 0)	0.904	.775	0.899	.620	-1.218	.773	-0.318	.729
(Type of offshoring = 1)	0[a]		0[a]		0[a]		0[a]	
Human Capital	1.723	.759	2.080***	.711	2.059**	.817	1.590*	.832
Country Risk	0.625*	.841	.237	.710	-1.799*	1.071	-1.282*	1.044
NIS	2.499**	1.020	-1.173*	.824	-1.022*	1.070	-1.235*	1.095
Cost	-0.087	.520	1.731***	.411	3.330***	.618	2.180***	.556
Cultural Difference	3.758***	.726	-0.684*	.373	-0.817**	.424	-1.280***	.464

N = 252; Log likelihood: - 180.569; χ^2 (36) = 425.562; Prob. $\chi^2 \leq 0.001$; pseudo $R^2 = 0.541$
a. This parameter is set to zero because it is redundant.
*** p ≤ 0.01; ** p ≤ 0.05; * p ≤ 0.1

Model with Control and Independent Variables (4C)

Variable	USA, Canada & Australia	S.E.	Japan, South Korea, Taiwan & Singapore	S.E.	India & China	S.E.	Middle East, S.America & Russia	S.E.
Intercept	-26.276***	6.130	-11.478***	3.881	-8.118*	4.393	-4.624	4.440
Log of Company Size	0.213	0.672	-0.509	0.626	-0.779	0.724	-0.421	0.708
Log of Company Age	0.353	0.947	-0.436	0.900	0.335	1.087	0.646	1.090
(Type of offshoring = 0)	1.160	0.852	0.980	0.698	-0.872	0.834	0.011	0.798
(Type of offshoring = 1)	0[a]		0[a]		0[a]		0[a]	
Human Capital	0.520	0.874	2.333***	0.873	2.743***	0.980	2.183**	1.000
Country Risk	0.522*	0.875	0.129	0.868	-2.126*	1.163	-1.626*	1.156
NIS	2.622**	1.049	-0.332*	1.019	-0.490*	1.179	-0.534*	1.224
Cost	-0.181	0.553	1.877***	0.478	3.229***	0.694	2.029***	0.643
Cultural Difference	4.065***	0.807	-0.850*	0.449	-0.875*	0.480	-1.292**	0.517
Experience of the company	0.519	0.406	1.722***	0.469	1.213**	0.549	1.672***	0.576
Reputation of the host company	0.140	0.565	-0.823**	0.388	-0.902**	0.459	-0.884*	0.456
Capability of the host company	0.083	0.342	0.090	0.316	-0.438	0.354	-0.507	0.347

N = 252; Log likelihood: - 164.065; χ^2 (48) = 458.750; Prob. $\chi^2 \leq 0.001$; pseudo $R^2 = 0.583$
a. This parameter is set to zero because it is redundant.
*** p ≤ 0.01; ** p ≤ 0.05; * p ≤ 0.1

Model with Control and Independent Variables (4D)								
Variable	**USA, Canada & Australia**	**S.E.**	**Japan, South Korea, Taiwan & Singapore**	**S.E.**	**India & China**	**S.E.**	**Middle East, S.America & Russia**	**S.E.**
Intercept	-80.276***	26.76	-15.721*	8.876	-12.054	10.47	-3.065	9.438
Log of Company Size	-3.315*	1.714	-1.180	1.125	-1.612	1.215	-0.491	1.102
Log of R&D Size	3.301	2.043	-1.428	1.026	0.333	1.247	-0.427	1.136
Log of Company Age	4.666*	2.347	-0.464	1.426	0.671	1.711	0.963	1.717
(Type of offshoring = 0)	3.871**	1.950	2.817**	1.435	0.166	1.593	1.088	1.450
(Type of offshoring = 1)	0[a]		0[a]		0[a]		0[a]	
Human Capital	2.799	1.722	3.901**	1.732	4.744**	1.865	4.141**	1.892
Country Risk	0.859*	2.873	-0.713	1.839	-4.759**	2.161	-5.089**	2.149
NIS	5.741*	3.404	-2.351	2.145	-2.979*	2.407	-3.085*	2.438
Cost	-4.856**	2.214	2.629**	1.168	4.287***	1.357	4.586***	1.345
Cultural Difference	7.649***	2.728	-0.903	1.080	-0.854	1.169	-0.467	1.162
Experience of the company	2.478**	1.184	3.323***	1.031	2.486**	1.175	2.669**	1.151
Reputation of the host company	0.463	1.089	-1.656	0.694	-2.794	0.829	-2.588	0.799
Capability of the host company	0.611	0.771	0.491	0.617	-0.236	0.652	-0.440	0.619
Speed of the project	0.683	0.928	3.231***	0.878	4.666***	1.117	0.931*	0.878
Quality of the project	0.713	0.831	-1.056	0.804	-1.086*	0.904	-0.831*	0.869
Routineness of the project	3.583	1.590	0.173	1.106	0.441*	1.247	0.174*	1.164
Interactivity of the project	1.948*	1.306	-0.805	0.640	-0.914	0.777	-1.527*	0.784
Innovativeness of the project	0.457*	1.419	-1.407	1.338	-0.296*	1.483	-0.860*	1.446
(Classification of the project = 1)	-7.845	7.585	15.859	4.554	24.071	5.555	-1.855	0.000
(Classification of the project = 2)	3.392	3.779	6.991	2.880	5.930	3.309	6.354	3.090
(Classification of the project = 3)	0[a]		0[a]		0[a]		0[a]	

N = 252; Log likelihood: - 95.623; χ^2 (76) = 595.634; Prob. $\chi^2 \leq 0.001$; pseudo $R^2 = 0.757$

a. This parameter is set to zero because it is redundant.

*** $p \leq 0.01$; ** $p \leq 0.05$; * $p \leq 0.1$

Multinomial Logistic Regression –Results

The analyses were based on four sets of models (4A, 4B, 4C and 4D) which tested the effects of country, firm and project level factors on location choice decision of R&D offshoring companies. Model 4D represents the overall results after applying all of the control and independent variables. The pseudo R^2 values for models 4A, 4B, 4C and 4D are 0.141, 0.541, 0583 and 0.757 respectively. This indicates that incrementally adding the different categories of independent variables improved the explanatory power of the models in terms of pseudo R^2. Further, Chi-square statistics suggest that all models are significant (model 4A at $p \leq 0.005$; models 4B, 4C and 4D at $p \leq 0.001$). The Chi-square significance levels also improved in the models with the incremental introduction of the independent variables.

The results of Multinomial Logistic Regression in Table 18 showed that the coefficients of all five country level factors (Human Capital, Country Risk, National Innovation System, Cost and Cultural Difference) are significant in the full model 4D.

Furthermore, the regression results indicated that five of the six project level determinants (Speed of the project, Quality of the project, Routineness of the project, Interactivity of the project, and Innovativeness of the project) were significant in the full model 4D. The coefficient of the other project level factor, classification of the project, was not statistically significant.

However, the coefficient of only one firm level factor was significant in the full model 4D, whereas in model 4C two of the firm level factors were significant. This indicates that the effect of project level factors on location choice decision of MNCs is greater than the effect of the company level factors.

Regarding the control variables, the coefficients of the USA, Canada & Australia ($\beta = 3.871$, $p < 0.05$) and Japan, South Korea, Taiwan & Singapore ($\beta = 2.817$, $p < 0.05$) regions on type of offshoring were significant, which indicate that MNCs prefer to offshore R&D projects to foreign affiliates in the USA, Canada & Australia and Japan, South Korea, Taiwan & Singapore regions rather than to non-integrated suppliers. The negative and significant coefficient of the USA, Canada & Australia ($\beta = - 3.315$, $p < 0.1$) on the size of company implies that the smaller the firm, the greater the likelihood that it will offshore R&D projects to the USA, Canada & Australia region rather than to the EU15 region. On the other side, the positive and significant coefficient of the USA, Canada & Australia ($\beta = 4.666$, $p < 0.1$) on the size of company indicates that the older the firm the greater the likelihood it will offshore R&D projects to the USA, Canada & Australia region rather than to the EU15 region. No other control variable was statistically significant in the full model 4D.

PLS Path Modelling

The results from the analysis of the outer model are presented in Table 19, where the outer loadings of the manifest variables or the items on the latent constructs have been provided. It also gives the Average Variance Extracted (AVE), Composite Reliability (CR) and Cronbach's alpha values for the latent constructs as estimated by Smart PLS. Table 8 shows the indicator loadings on the construct are all ≥ 0.7 (Hulland, 1999) and significant. Additionally, the table also indicates that all CR ≥ 0.7 (Bagozzi & Yi, 1988); all AVE ≥ 0.5 (Bagozzi & Yi, 1988) and Cronbach's alpha values of all variables ≥ 0.7. These are all good indicators of reliability and convergent validity with respect to the measurement model. The same holds true for discriminant validity based on the Fornell-Lacker criterion (1981).

Table 19: PLS Measurement Model results – Model 4

Variable	Item Name	Outer Loadings	AVE	CR	Cronbach's Alpha
Human Capital	HumanCapital_1	0.8436	0.7645	0.8503	0.8115
	HumanCapital_2	0.8444			
	HumanCapital_3	0.8007			
Country Risk	Risk_1	0.7612	0.6733	0.8444	0.8077
	Risk_2	0.8976			
	Risk_3	0.8896			
	Risk_4	0.7139			
	Risk_5	0.8247			
National Innovation System	NIS_1	0.8236	0.7407	0.8548	0.8374
	NIS_2	0.8214			
	NIS_3	0.9005			
	NIS_4	0.8219			
Cultural Difference	Culture_1	0.8737	0.884	0.9478	0.8815
	Culture_2	0.902			
	Culture_3	0.8855			
	Culture_4	0.8787			
	Culture_5	0.887			
Cost	Cost_1	0.8588	0.8197	0.8717	0.8263
	Cost_2	0.8555			
	Cost_3	0.8627			
Experience	Exp_1	0.7801	0.6275	0.7316	0.7642
	Exp_2	0.9304			
	Exp_3	0.6389			

The primary criterion for the assessment of the structural model is R^2 (Hair et al., 2012) which in this case is 0.7367 (Table 20), indicating that 73.67 % of the variance in the location choice decision of companies is explained by exogenous variables. The R^2 values indicate a moderately strong PLS model (Chin, 1998).

Table 20: PLS modelling with Location choice as the Endogenous variable – Model 1

Exogenous Variables	Path Coefficients	t-statistics (from bootstrapping)	R^2
Log of Company Size	0.0185	0.197	0.7367
Log of R&D Size	-0.0715	0.814	
Log of Company Age	0.0200	0.352	
Type of offshoring	0.0381	0.437	
Human Capital	0.1902	1.658*	
Country Risk	-0.1840	2.205**	
National Innovation System	-0.1519	1.822*	
Cost	0.3803	3.194***	
Cultural Difference	-0.3285	2.572**	
Experience	0.1750	2.035**	
Reputation of the host company	-0.1376	2.390	
Capability of the host company	-0.0568	0.737	
Speed of the project	0.1182	2.099**	
Quality of the project	-0.1254	2.301**	
Routineness of the project	0.1423	1.840*	
Interactivity of the project	-0.1830	1.705*	
Innovativeness of the project	-0.1699	1.992**	
Classification of the project	-0.2358	0.751	

The path coefficients for the model are presented in Table 20. The control variables in the model have been italicised. Table 20 shows that PLS results also do not differ from the results of the Multinomial Logistic Regression in Table 18.

It can be seen from Table 20 that the path coefficient for human capital, cost of doing R&D in the country, experience of the firm, speed of the completed R&D project and routineness of the R&D project are positive and significant, while the path coefficient for country risk, national innovation system, cultural difference, quality, interactivity, and innovativeness of the R&D project are negative and significant, similar to the result from the Multinomial Logistic Regression.

With regard to the control variables, the PLS modelling implies that there is a positive relationship between type of offshoring and location, which indicates that MNCs prefer the USA, Canada & Australia, EU15, and Japan, South Korea, Taiwan & Singapore regions for captive offshoring, while India & China, and the Middle East, South America, Africa & Russia regions are preferable locations for offshore outsourcing. PLS path modelling shows the same results relating to size, R&D size and age of the company, as in the MLR model, have been observed, but none of them are statistically significant.

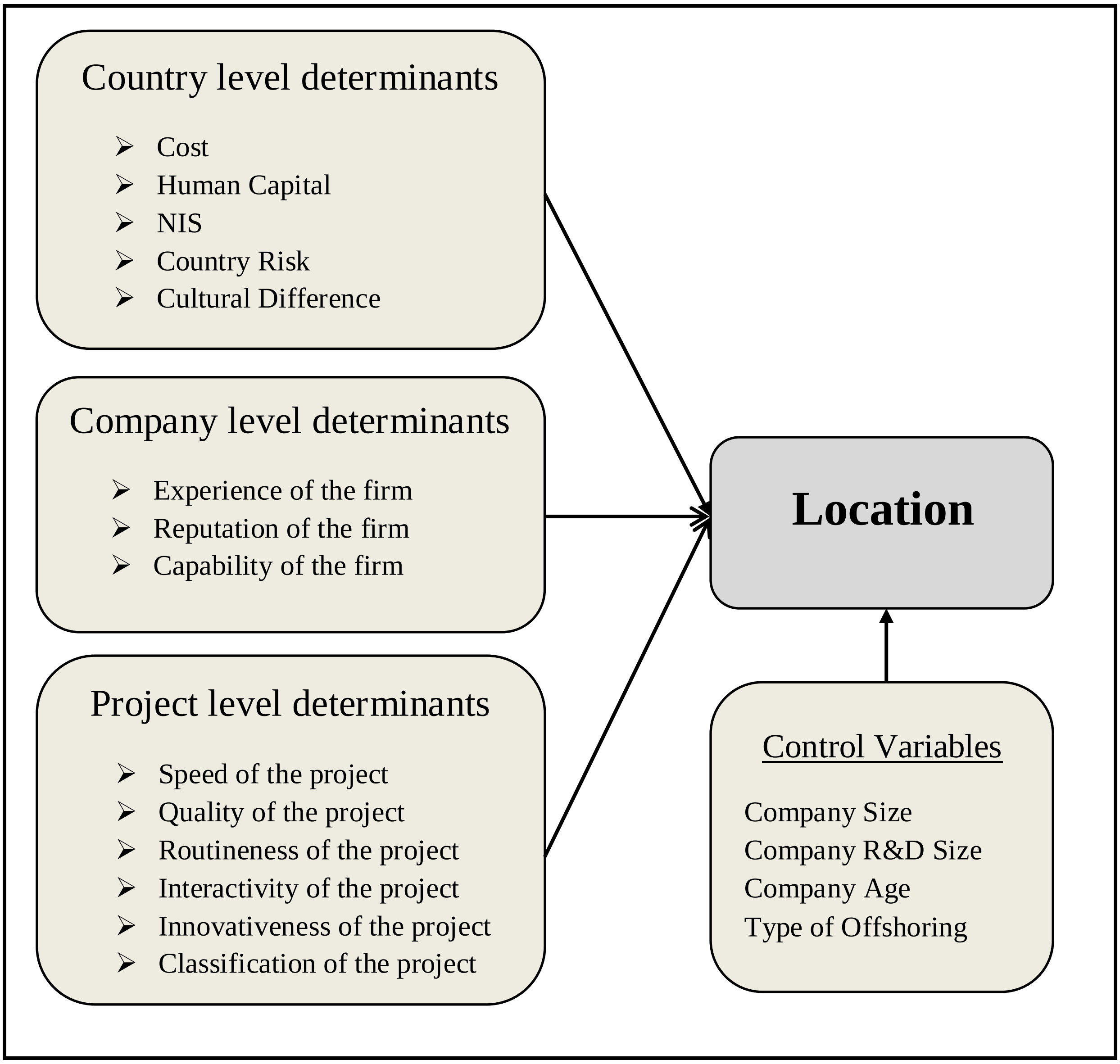


Figure 12: Full Model
Adopted from Demirbag and Glaister (2010).

Innovativeness of the offshored R&D activities

This section deals with the analysis of the difference between the degrees of innovativeness of the R&D activities offshored to developed countries and developing or emerging countries. Also, the difference between the degrees of innovativeness of the R&D activities offshored to foreign affiliates of the company and to non-integrated suppliers will be investigated by using one-way ANOVA and factorial ANOVA methods.

One-Way ANOVA

The one-way ANOVA results of the degree of innovativeness of the offshored R&D activities are presented in Table 21 and Appendix C.

TABLE 21 – the results of one-way ANOVA

The degree of innovativeness of the offshored R&D activities

			Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)		163.835	4	40.959	64.346	.000
	Linear Term	Unweighted	21.688	1	21.688	34.071	.000
		Weighted	11.744	1	11.744	18.450	.000
		Deviation	152.091	3	50.697	79.644	.000
Within Groups			157.225	247	.637		
Total			321.060	251			

The results of one-way ANOVA analysis in Table 21 showed that there are significant differences between the degree of innovativeness of R&D activities offshored to different locations, $F (4, 247) = 64.35$, $p < 0.05$, $\omega = 0.71$. However, based on the results from Table 21 it will be wrong to suppose that there is an exact difference between the degree of innovativeness of the activities offshored to developed and developing countries, since it is not known which locations differ. For further support post-hoc tests were done. The results of post-hoc tests presented in Appendix C showed that the degree of innovativeness of the R&D activities offshored to the USA, Canada & Australia and the EU15 regions is higher than the degree of innovativeness of the R&D activities offshored to India & China and the Middle East, South America & Russia regions. So, these findings support hypothesis 15. The results of the one-way ANOVA analysis are also illustrated in Figure 13.

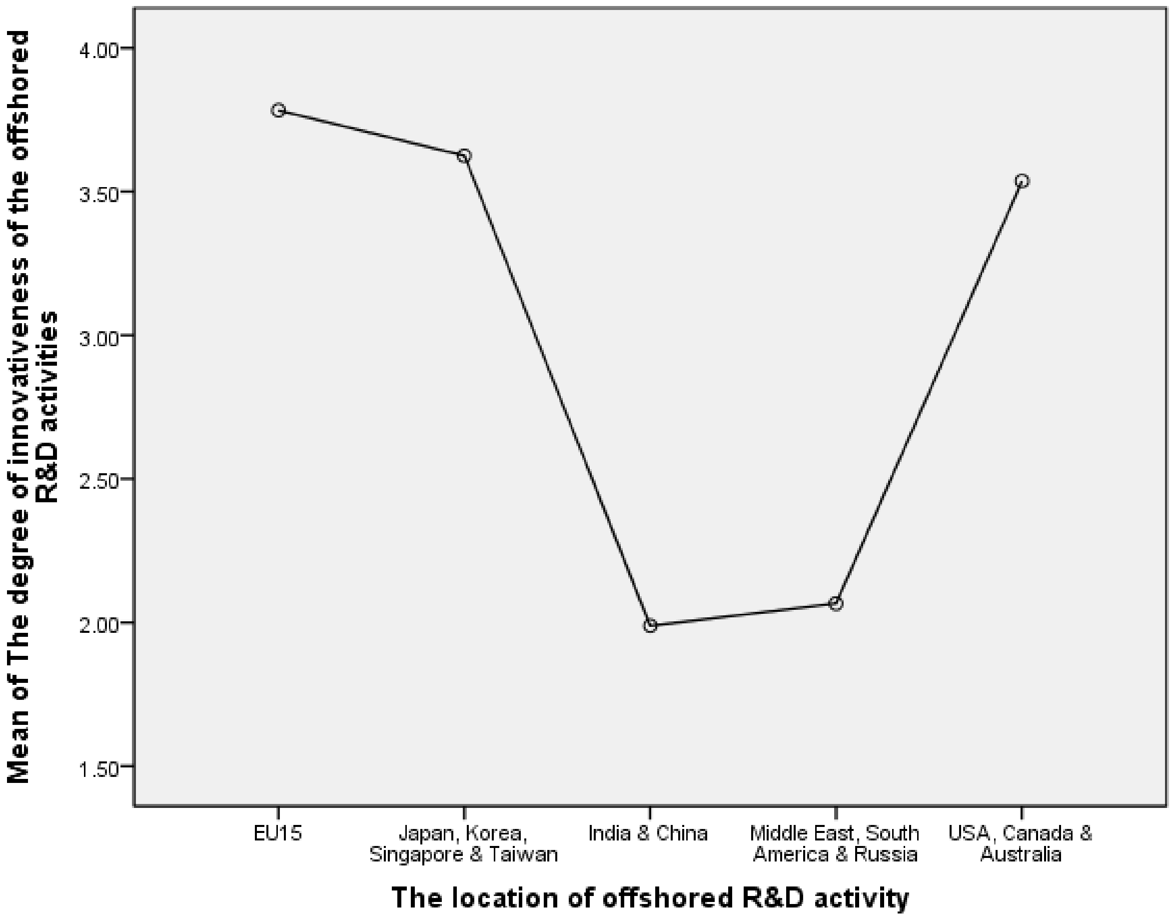


Figure 13: The degree of innovativeness vs. location of offshored R&D activity

Two-way ANOVA

In order to investigate if there is a significant difference between the degrees of innovativeness of the R&D activities offshored to foreign affiliates of the company and to non-integrated suppliers, the factorial ANOVA method was used. The results of factorial

ANOVA analysis on the degree of innovativeness of the offshored R&D activities have been presented in Table 22 and Appendix C.

Table 22 – The results of two-way ANOVA analysis

Tests of Between-Subjects Effects

Dependent Variable: The degree of innovativeness of the offshored R&D activities

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	221.828[a]	9	24.648	60.109	.000
Intercept	1285.395	1	1285.395	3134.737	0.000
Type	54.280	1	54.280	132.375	0.000
Location	25.640	4	6.410	15.632	0.000
Type * Location	3.009	4	0.752	1.834	0.123
Error	99.232	242	0.410		
Total	2593.563	252			
Corrected Total	321.060	251			

a. R Squared = .691 (Adjusted R Squared = .679)

Table 23 – Test Results

Dependent Variable: The degree of innovativeness of the offshored R&D activities

Source	Sum of Squares	df	Mean Square	F	Sig.
Contrast	54.280	1	54.280	132.375	0.000
Error	99.232	242	.410		

The results of two-way ANOVA analysis in Table 22 indicate that the F-ratio is significant for type and location variables, which means that overall, when the effects of location on the degree of innovativeness of the activity is ignored, the type of offshoring has an influence on the degree of innovativeness of the activities. In other words, other things being equal, captive offshoring and offshore outsourcing affect the degree of innovativeness of the offshored activities differently. The results of Helmert contrast in Appendix C indicate that the degree of innovativeness in the R&D activity offshored to foreign affiliates of the company and the degree of innovativeness in the R&D activity offshored to non-integrated suppliers are different, and Table 23 shows that this difference is statistically significant, $F (1, 242) = 132.375$, $p < 0.001$. The results in Table 22 also imply that the F-value for interaction between the effect of type of offshoring and location of offshored R&D activity is statistically non-significant, $F (4, 242) = 1.834$, $p > 0.1$. This actually means that the effect of location of offshored activities was not different for activities offshored by captive offshoring type and for activities offshored by offshore outsourcing type. Overall, hypothesis 17 which stated that the degree of innovative of R&D activities offshored to foreign affiliates of the company is higher than the R&D activity offshored to non-integrated suppliers was confirmed. The results of two-way ANOVA analysis are illustrated in Figure 14.

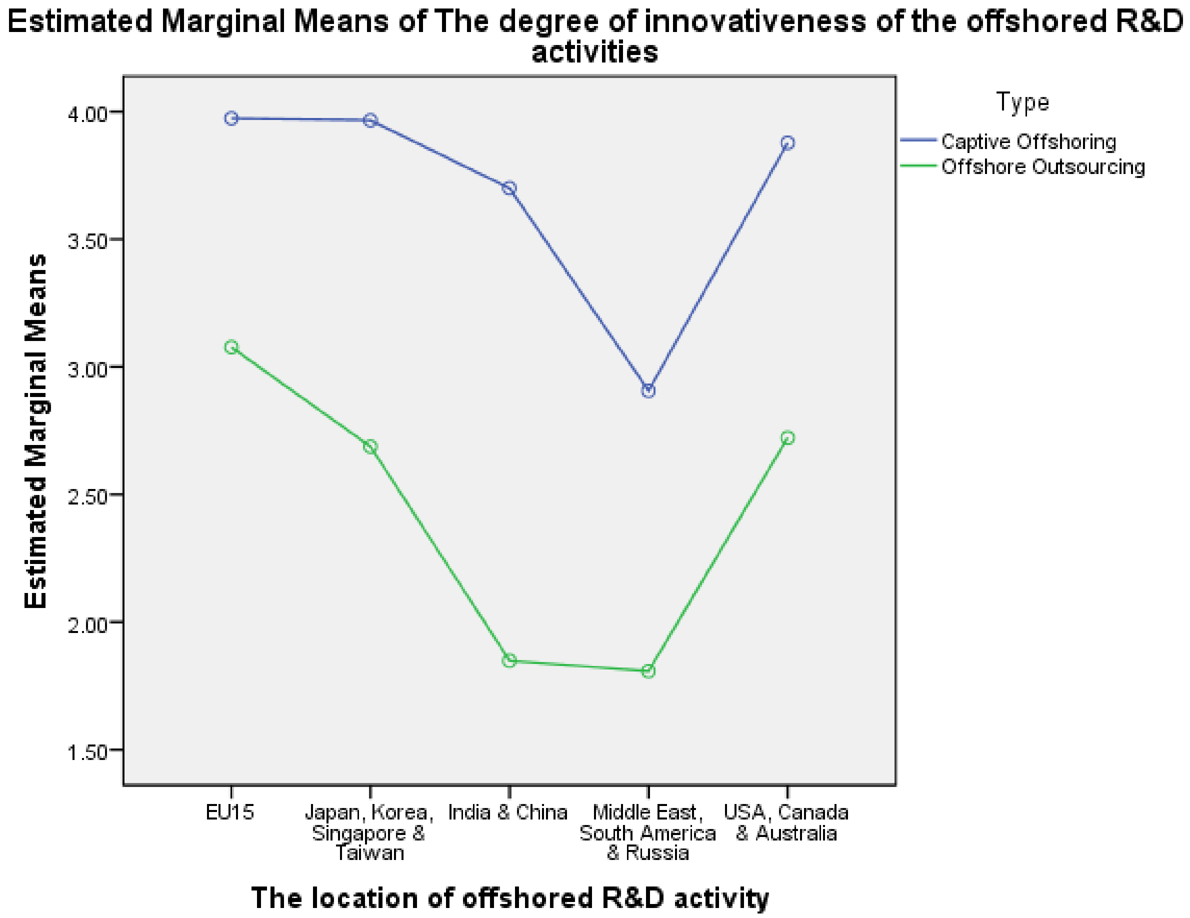


Figure 14: The degree of innovativeness vs. location of captive offshoring and offshore outsourcing

Routineness of the offshored R&D activities

This section deals with the analysis of the difference between the degrees of routineness of the R&D activities offshored to developed countries and developing or emerging countries. Also, the difference between the degrees of routineness of the R&D activities offshored to foreign affiliate of the company and to non-integrated suppliers will be investigated by using one-way ANOVA and factorial ANOVA methods.

One-Way ANOVA

The one-way ANOVA results of the degree of routineness of the offshored R&D activities have been presented in Table 24 and Appendix C.

TABLE 24 – the results of one-way ANOVA

The degree of routineness of the offshored R&D activities.

			Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	(Combined)		142.255	4	35.564	38.298	.000
	Linear Term	Unweighted	11.396	1	11.396	12.272	.001
		Weighted	5.685	1	5.685	6.122	.014
		Deviation	136.570	3	45.523	49.023	.000
Within Groups			229.366	247	.929		
Total			371.621	251			

The results of one-way ANOVA analysis in Table 24 showed that there are significant differences between the degree of routineness of R&D activities offshored to different locations, $F(4, 247) = 38.30$, $p < 0.05$, $\omega = 0.61$. However, based on the results from Table 24 it would be wrong to suppose that there is an exact difference between the degree of routineness of the R&D activities offshored to developed and developing countries, since I do not know which locations differ. Therefore, post-hoc tests were done. The results of post-hoc tests presented in Appendix C showed that the degrees of routineness of the R&D activities offshored to India & China and the Middle East, South America & Russia regions are higher than the degree of innovativeness of the R&D activities offshored to the USA, Canada & Australia and the EU15 regions. So, these findings support hypothesis 16. The results of the one-way ANOVA analysis are illustrated in Figure 15.

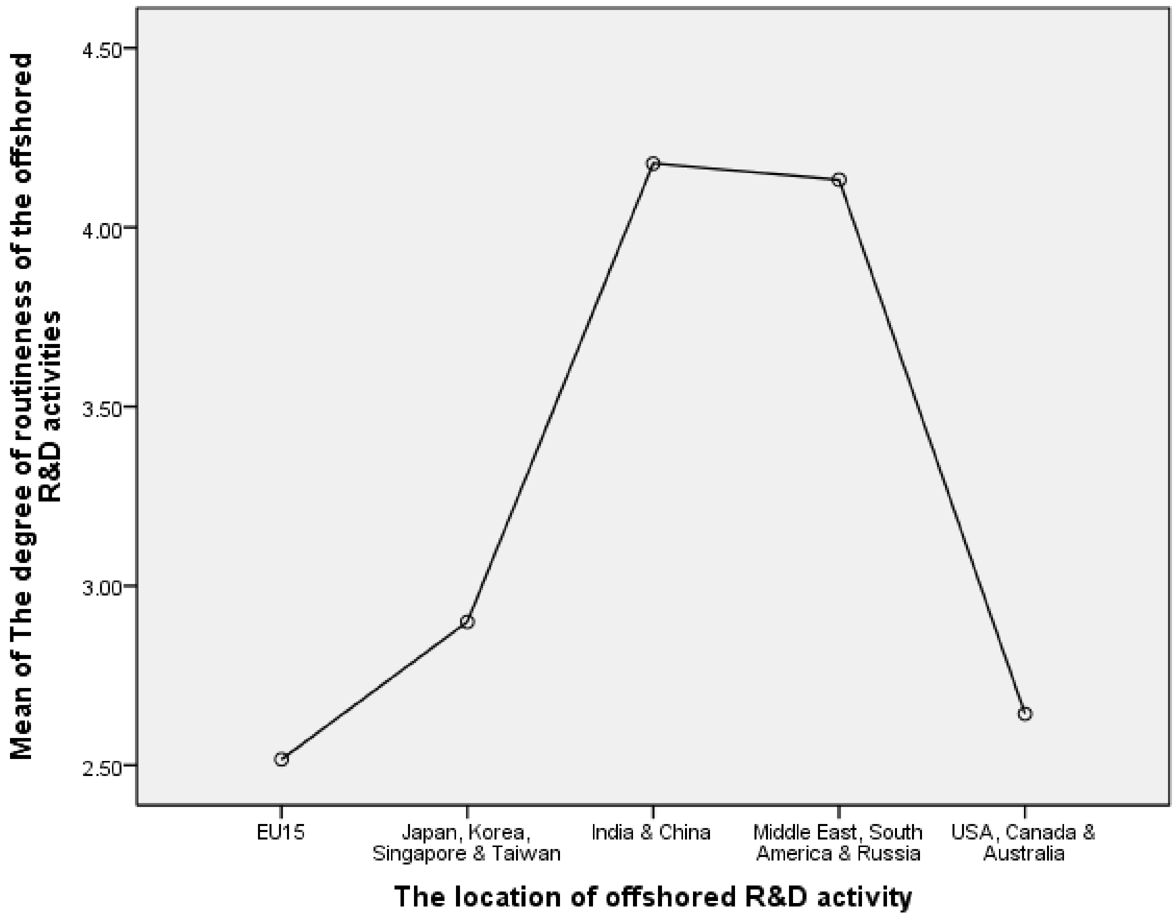


Figure 15: The degree of routineness vs. location of offshored R&D activities

Two-way ANOVA

In order to investigate if there is a significant difference between the degrees of routineness of the R&D activities offshored to foreign affiliates of the company and to non-integrated suppliers, the factorial ANOVA method was used. The results of factorial ANOVA analysis on the degree of routineness of the offshored R&D activities are presented in Table 25 and Appendix C.

Table 25 – The results of two-way ANOVA analysis
Tests of Between-Subjects Effects

Dependent Variable: The degree of routineness of the offshored R&D activities

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	197.983[a]	9	21.998	30.659	.000
Intercept	1512.349	1	1512.349	2107.765	.000
Type	46.339	1	46.339	64.583	.000
Location	28.143	4	7.036	9.806	.000
Type * Location	3.454	4	.863	1.203	.310
Error	173.638	242	.718		
Total	3026.875	252			
Corrected Total	371.621	251			

Table 26 – Test Results

Dependent Variable: The degree of routineness of the offshored R&D activities

Source	Sum of Squares	df	Mean Square	F	Sig.
Contrast	46.339	1	46.339	64.583	.000
Error	173.638	242	.718		

The results of two-way ANOVA analysis in Table 25 indicate that the F-ratio is significant for type and location variables, which mean that overall, when the effects of location on the degree of routineness of the activity are ignored, the type of offshoring has an influence on the degree of routineness of the activities. In other words, other things being equal, captive offshoring and offshore outsourcing affect the degree of routineness of the offshored activities differently. The results of Helmert contrast in Appendix C indicate that the degrees of routineness in the R&D activity offshored to foreign affiliates of the company and the degree of routineness in the R&D activity offshored to non-integrated suppliers are different, and Table 26 shows that this difference is statistically significant, $F(1, 242) = 64.583$, $p < 0.001$. The results in Table 25 also imply that the F-value for interaction between the effect of type of offshoring and location of offshored R&D activity is statistically non-significant, F (4, 242)

= 1.834, p > 0.1. This actually means that the effect of location of offshored activities was not different for activities offshored by captive offshoring type and for activities offshored by offshore outsourcing type. Overall, hypothesis 18 which states that the degree of routineness of R&D activities offshored to non-integrated suppliers is higher than the R&D activity offshored to foreign affiliates of the company was confirmed. The results of two-way ANOVA analysis are also illustrated in Figure 16.

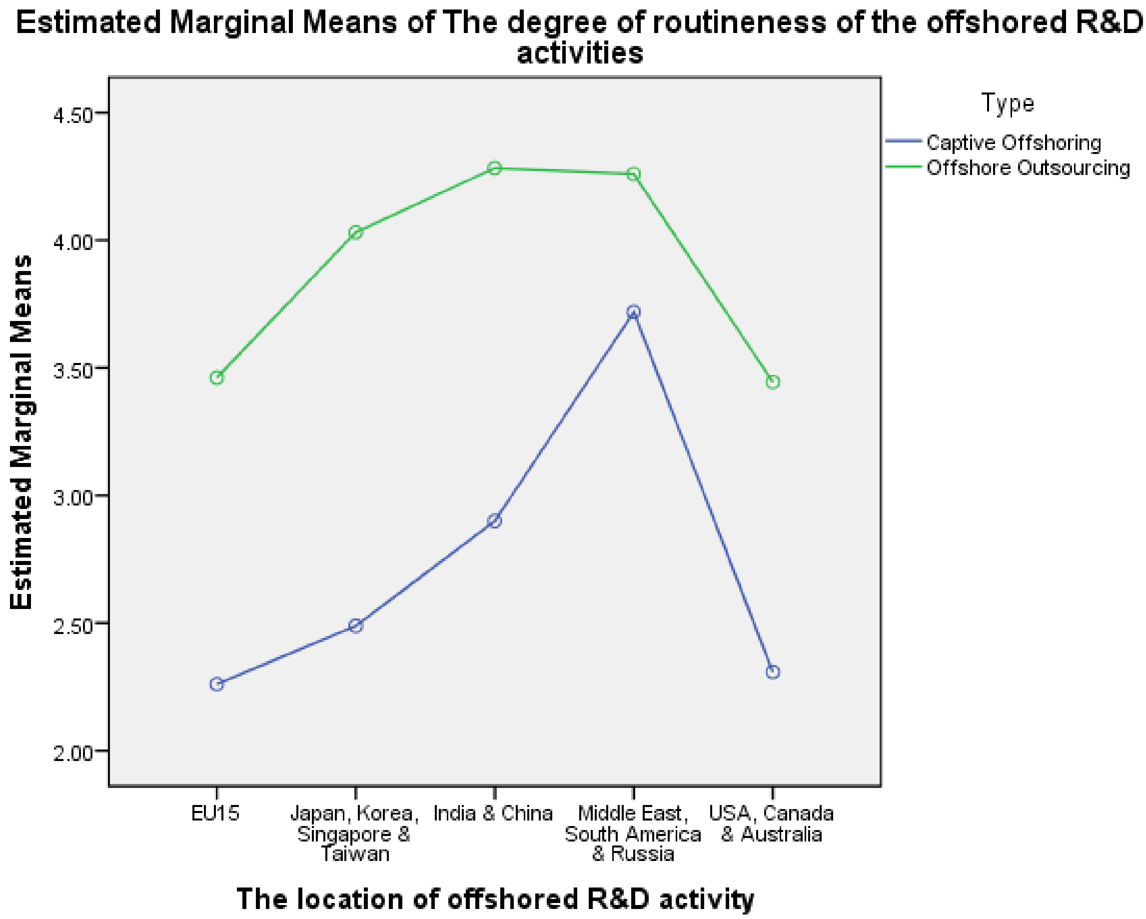


Figure 16: The degree of routineness vs. location of captive offshoring and offshore outsourcing

CHAPTER 6 – DISCUSSION AND CONCLUSION

Based on the transaction cost theory, resource based view and eclectic paradigm, this study attempted to analyze the effects of the main determinants of the location choice decision for offshoring of R&D activities, using a multi-level survey of MNCs. This chapter will discuss, summarize and highlight the main findings from this study. Further it will analyze the potential implications of the key findings of this study and include possible recommendations for researchers on how to continue the future research in the R&D offshoring area. Also, there will be some recommendations for government analysts on how to attract foreign companies to invest in the economy and R&D infrastructure of the country. Subsequently, the main contributions of this study will be highlighted. To conclude, this section will discuss the limitations of this study and explore future research areas which should be investigated.

Key Findings

The main objectives of this study as detailed in Chapter 1, include putting together a multilevel perspective for analyzing the location choice decision for R&D offshoring, that incorporates country, company and project level perspectives for MNCs offshoring R&D activities. The determinants of the location choice decision for offshoring of R&D activities were chosen as the main objective of this study, since the literature review in Chapter 2 reveals that there are a number of gaps that needed to be addressed. Based on the transaction cost theory, resource based view and eclectic paradigm and the literature review (Chapter 2) this study proposes a number of hypotheses in Chapter 3. The study adopted quantitative methods employing a survey instrument to collect data from managers of MNCs offshoring R&D activities in Chapter 4. In Chapter 5, the resulting data was analyzed at individual levels and also at an integrated level, to understand the relative importance of these determinants and also to understand how their combined and individual effects differ. Multinomial Logistic Regression was adopted for the analysis which was also supplemented with PLS modelling to validate the measurement and structural models separately. This analysis was used to test the various models and hypotheses developed for this study (Chapter 3) and the results were largely as expected with some unexpected outcomes.

Table 32: Summary of the analysis of hypotheses testing

Hypothesis	Significance of results	
	Individual model	Full model
H1 – Cost	Significant	Significant
H2 – Human Capital	Significant	Significant
H3 – NIS	Significant	Significant
H4 – Country Risk	Significant	Significant
H5 – Cultural Difference	Significant	Significant
H6 – Experience	Significant	Significant
H7 – Reputation	Significant	Not significant
H8 – Capability	Not significant	Not significant
H9 – Classification	Not significant	Not significant
H10 – Routineness	Significant	Significant
H11 – Interactivity	Significant	Significant
H12 – Innovativeness	Significant	Significant
H13 – Speed	Significant	Significant
H14 – Quality	Significant	Significant
H15 – The degree of innovativeness (Country)	Significant	
H16 – The degree of routineness (Country)	Significant	
H17 – The degree of innovativeness (type of offshoring)	Significant	
H18 - The degree of routineness (type of offshoring)	Significant	

Discussion

One of the most interesting findings from this study is the dominating influence of country level factors (cost, human capital, NIS, country risk and cultural difference) and the characteristic of the project (speed, quality, routineness, interactivity, and innovativeness) on the process of location choice decision for offshoring of R&D activities. On comparing the results of the different analyses (Models 1 through 3) at individual levels, it can be seen that the country and project level determinants have the most significant effect on location choice, accounting for most its variation (higher pseudo R^2). This effect was also very prominent in the integrated model (Model 5) where it was jointly analyzed with the other determinants. In fact, after introducing the project level factors to the regression equation, some of the other determinants at company level lost their significance, which supports the statement.

The multilevel perspective adopted here has helped understand the relative importance of these different levels of determinants and also recognize their joint effects on the location choice decision of R&D offshoring. Here the integrated model has helped realize the relative importance location determinants in comparison to the others. Hence it is worthwhile noting that most offshoring studies deal with only some of these perspectives and hence analyze these determinants in isolation. Such models may not always help us fully comprehend the process of R&D offshoring.

The country level factors analyzed with this model include cost, human capital, country risk, NIS and cultural difference that could influence the location choice decision of R&D offshoring. Of these five determinants, cost, human capital and country risk have gathered the most attention in the offshoring literature. NIS and cultural difference have been relatively ignored in the literature when compared to the other three determinants that have been considered here.

The R&D cost level emerges as an important determinant of location choice. Both the multinomial logistic model and the marginal analyses indicate a rank order of cost in relation to the country clusters. Therefore my findings related to cost and the availability of human capital should be interpreted in conjunction with each other. These findings are consistent with those of recent studies of offshore service location choice (Doh et al., 2009; Manning et al., 2008), which have identified a large pool of talent as one of the principal considerations in location choice (Lewin et al., 2007).

My findings indicate an interesting division of R&D cost between country clusters. The findings imply that the more important the cost factor in the location choice decision of R&D offshoring, the more likely that the Japan, South Korea, Taiwan and Singapore and Middle East, South America, Africa & Russia regions are selected as an offshore R&D project location over the EU15, and the more likely the India & China region is selected over both the Middle East, South America, Africa & Russia and Japan, South Korea, Taiwan and Singapore regions. While the USA, Canada & Australia region is more likely to receive offshore R&D projects that require high level knowledge because of its highly developed NIS, the India & China region is more competitive in offering relatively lower R&D cost with a lower quality of NIS. The EU15, however, does not appear to be competitive in either of these aspects. While the EU15 countries have high NIS compared to India & China, smaller pools of science and engineering talent in most of the countries of the EU15 decreases the likelihood of the EU15 being an offshore location for high knowledge projects. Further, R&D costs in the EU15 are not competitive compared to India & China or the Middle East, South America, Africa & Russia regions.

The findings show that the NIS in the USA, Canada & Australia region is a highly important factor in attracting R&D projects, and compared to the India & China and the Middle East, South America, Africa & Russia regions the EU15 seems to have a better competitive position. In terms of NIS for offshoring the R&D projects, the USA, Canada & Australia are more likely to be chosen over all other regions. From the NIS aspect, the India & China region is less likely to be a location for international R&D projects over the USA, Canada & Australia, Japan, South Korea, Taiwan and Singapore, and the EU15. This indicates a division of NIS between India & China, the EU15, and USA, Canada & Australia, indicating a trade-off between NIS and R&D cost dimensions, which may be interpreted as a division of R&D labor between regions or even Asia as a whole. The NIS coefficients revealed significant results for all regions, implying that NIS is a significant determinant of offshore R&D location decisions. This indicates that policy makers should consider this in their policy related decisions.

The findings related to the availability of human capital indicate that this is an important attraction for Japan, South Korea, Taiwan and Singapore, India & China, and the Middle East, South America, Africa & Russia regions. My analysis reveals that the pool of R&D related skills (science and engineering talent) diminishes the likelihood of European Union countries as a location for offshore R&D projects and supports some recent studies which have identified the diminishing availability of technical skills for the USA and Western Europe as a contributor to the decision to offshore the location of services (Doh et al., 2009; Lewin et al., 2009; Manning et al., 2008). The dynamics of the pool of 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 economics are selecting advanced degrees in science and engineering, and this trend affects all the developed countries including the USA and EU15 region. At the same time, Asian countries such as India, China, Taiwan and Singapore, and certain countries in South America and the Middle East, and Russia are becoming recognized as suppliers of highly qualified engineering and science talent. The rise in the frequency of companies citing access to the global pool of qualified personnel and expertise as strategic drivers for offshoring R&D activities and for selecting certain country locations may be indicative of companies recognizing the growing shortage of technical talent in the Western world. In the past few years, the amount of foreign science and engineering talent entering the USA has declined, while the return rate ("reverse brain drain") to home countries has been increasing. This is, to a large extent, due to a cutback in the H1B visa quota in 2003 (Lewin et al., 2009), increasing opportunities and incentives for studying and doing research in science and engineering fields outside the USA, and the emergence of attractive work opportunities and living conditions in home countries (Manning et al., 2008). In order to adapt to this significant change in the environment of the USA, companies entered a global search for talent that led them to offshore R&D activities to countries and cities where they could find sufficient pools of qualified personnel and expertise for increasingly advanced and complex R&D projects.

Country risk was also significant in influencing the location of R&D projects, reflecting perhaps offshoring firms' sensitivity to deploying their R&D activities in politically risky environments for fear of unexpected fiscal policy and regulatory changes, or other disruptions. Given the heavier weighing in my country risk measure of overall government stability, socio-economic and investment profile, and internal and external conflict, firms' reactions are likely to correspond to these overcharging conditions rather than to any specific aspects of government behavior. Moreover, given the extremely high negative correlation between R&D cost and country risk, many firms appear to be implicitly assessing the costs of risk and strategically trading off mitigation against higher costs.

The results of the analyses also showed that cultural closeness between home and host country of offshoring firms is an important factor in the location choice decision. It is not surprising that the role of the English language, which is an important component of cultural closeness factor, emerged as a significant factor in determining the location of UK-based offshore facilities, since English competency appears to be central to the human resource needs of these offshoring firms, particularly for certain sectors.

The firm level factors analyzed with this model include experience, reputation and capability of the firm that could influence the location choice decision of R&D offshoring. Of these three determinants, the results of analysis for experience and reputation were statistically significant, while the hypothesis related to the capability of the firm was not supported.

The results from multinomial logistic regression show that the experience of the firm also affects the location choice decision of the R&D offshoring process. As the number of projects and activities offshored by the firm increases, the Emerging Asian Countries, Middle East, South America, Africa & Russia regions become more likely destinations for R&D projects. While firms offshoring to India & China compensate higher political risk by country experience, firms offshoring to the Middle East, South America, Africa & Russia regions, and the Emerging Asian Countries are more likely to have offshore project experience prior to offshoring an R&D project, which then compensates for risk perception. This finding indicates that offshoring firms either learn from earlier offshore R&D experience in other regions, or from direct country experience which then creates a trade-off between perceived risk and symbiotic learning.

The analysis shows that the more important the reputation of the firm the lower the probability of the firm offshoring their R&D activities to emerging countries. Firms in some industries such as pharmaceutical and biotechnology are more likely to retain their core activities in-house or offshore them to developed economies due to the negative effect on reputation of the firm. Offshore outsourcing has received bad publicity in developed home countries due to the associated job losses. Firms in these countries may refrain from using the offshoring strategy if maintaining the reputation of the firm is of greater importance.

My findings indicate that the hypothesis related to the capability of the firm was not supported. The results of the analysis were not significant. The definition of the capability of the firm is not clear in international business literature and it is not so easy to measure the capability of the firm in practice. Even though I have constructed the proper questions and questionnaire structure related with the capability of the firm, there is a chance of being misunderstood. This misunderstanding can cause the results of the analysis to be not significant.

The last group of determinants analyzed in this thesis was the project level factors. The results of the analysis show that speed, quality, innovativeness, routineness, and interactivity of the project affect the location choice decision of R&D offshoring, while the effect of classification of the R&D project for location choice was not significant. Also, the results indicate that the degree of innovativeness of R&D projects offshored to developed countries is higher than the degree of innovativeness of R&D projects offshored to emerging and developing countries. Furthermore, it was shown that the degree of innovativeness is higher in the captive offshoring process than in offshore outsourcing. However, in the case of the degree of routineness of the offshored R&D projects the situation is opposite to the case above. The degree of routineness is higher for R&D projects offshored to emerging and developing countries than projects offshored to developed countries. Moreover, the degree of routineness for R&D projects offshored to non-integrated suppliers is higher than the degree of routineness for R&D projects offshored to foreign affiliates.

Contributions

Theoretical and methodological contributions

Theoretical contributions: The thesis's theoretical contributions lie in its use of multiple theories to study the phenomenon. Previous studies have used transaction cost economics or resource based view to examine offshoring of activities without integrating these two theories. These theories have often been viewed as having opposing propositions especially regarding offshoring and outsourcing. Hypotheses were developed by jointly looking at them and thus it was shown that these two theories are not conflicting. Also, Dunning's eclectic paradigm was used to investigate the determinants of the location choice decision.

Methodological contributions: Methodologically, this dissertation makes a number of contributions to the international business and strategic management field. Most of the studies in this field have used secondary data, which may not correctly measure the constructs. By using a carefully constructed survey and properly selecting the sample of the survey, this problem was solved. The thesis also attempts to combine macro-level, meso-level and micro-level research by studying the phenomenon at multiple levels. The research questions have been examined at the following levels of analysis: country, company and project level. Conducting multi-level research is relatively uncommon in the offshoring literature; however, it gives a detailed and clear understanding of this process. The empirical study in this thesis uses sophisticated statistical techniques to address the questions raised by the gaps in the literature. In spite of the wide spread use of the multinomial logistic regression model in the economics literature, the international business literature has yet to adopt this technique. Also, the PLS path modelling was used in order to approve the result of multinomial logistic regression. By using multi-level analysis, MLR and PLS path models, this thesis examines the location choice decision of R&D offshoring deeper than the studies before.

Practical contributions

Contributions for governments and policy makers: The recent global recession has turned out to be a boon as well as a bane for the offshoring phenomenon. On one hand, many MNCs from developed countries are looking at these alternate sourcing strategies to reduce costs, improve efficiency and profits in this stagnant economy. But on the other hand, the weakening Euro and Dollar accompanied by raising wage costs in developing countries has led to a slowdown of this phenomenon. Findings from this thesis show that companies do not offshore only to reduce the cost of activity. Host country governments that are seeing a decrease in their offshoring industry must try to attract investments driven by human capital, NIS and country risk factors as these are less sensitive to changes in wage costs. Host country governments can try to create a more auspicious environment for these types of activities by encouraging higher education, improving the quality and quantity of educational institutions, availability of skilled workforce, knowledge infrastructure and regulations, lower political risks as well as better intellectual property rights protection. Establishing a certain threshold for regulation and standards is essential for attracting offshoring of R&D activities. Since companies, especially in highly regulated industries such as biotechnology and pharmaceuticals, face tough regulations at home, they do not consider countries without basic standards and regulations when offshoring their innovative R&D activities. This point should be also realized by policy makers, and policies in order to attract innovative R&D projects should be constructed. The research done on the degree of innovativeness and routineness of the offshored R&D activities in Chapter 5 shows that developing and emerging countries are still in the nascent stages of offshoring. Host country governments can play an important role in increasing their country’s share of this upcoming new market. For example, many developing countries like China and India are highly dependent on offshore outsourcing. To progress from being a provider of basic activities to more high value activities, the government must develop local industry and encourage growth of specialized third party vendors to attract such investments. In addition, in this study, the cultural difference between the host and home country is found to affect the location choice decision. The closer the cultural distance, business mentality, environment and communicating language between host and home country, the higher the possibility of R&D activity being offshored to that location. The policy of governments should be toward developing communicating language and establishing business mentality and convenient environment for foreign investors.

Managerial contributions: This research has important managerial contributions for R&D managers and investment consulting companies. The findings of the thesis has shown that cost saving is not primary determinant in offshoring of innovative R&D activities. Human capital, NIS, and knowledge infrastructure is more important factors for innovative projects. Also, managers should not forget about the IPR in the host country, which is crucial determinant for high value added tasks. It was mentioned before that there are three main motives for offshoring of R&D. The first motive is cost saving by lowering operational costs, controlling cost, and freeing resources for more profitable activities. The second is related to process improvement, and the need to concentrate on core competences, to achieve flexible internal reorganization, to accelerate projects, gain access to a flexible workforce, and to sharpen business focus. And the third motive is capability enhancement, which includes obtaining access to highly skilled talent unavailable internally and improving service quality. By indicating the motive of R&D offshoring project it will be easily for consulting companies to suggest the location for MNCs. If the motive is only cost saving, China & India will be the most appropriate location for R&D project. In order to concentrate on core competency the firm can offshore R&D project to EU countries, USA, Canada and Australia. However, if the main motive of project offshoring is access to talent pool, the best location will be Japan, Taiwan, Singapore and South Korea.

Limitations

As is the case with research, this thesis has a few limitations. The first limitation of this thesis is the relatively low response rate of MNCs that participated in the online survey. The population for this study was 941 firms; however, it was able to get complete responses from only 126 firms. The marginally low response rate is due to high privacy concerns by the firms offshoring R&D activities and unwillingness to share firm specific data. But even though the response rate is low, the number of firms participating in the survey is enough to have reliable results. Also, each firm gave detailed information about two offshored activities: captive offshoring and offshore outsourcing. So, the number of offshored R&D activities is 252, which is enough to construct the model and check the hypotheses.

Firm's R&D location choice decision was examined on the basis of answers given by the individual R&D manager or R&D director, and it was assumed that these managers and directors were somehow involved in the procedure of location choice decision for offshoring of R&D activities. The answers about how they evaluated the determinants of location choice decision must be assumed to be representative of the opinion of the company's headquarters or the whole MNC decision center. But the responses might have included answers from new managers who were not part of the actual decisions that were made in the past. This limitation can be overcome by conducting face to face interviews with R&D managers and directors who took place in the location choice decision of R&D offshoring.

Future research

This thesis focused on offshoring of R&D activities. A few avenues for future research are suggested in this section. Evidence from this study suggests that firms have to choose between captive offshoring and offshore outsourcing. However, there have been discussed the third type of offshoring called joint venture offshoring in the definition section of Chapter 2. So, additional research can be done in order to investigate the joint venture offshoring process.

Although the TCE, RBV, and OLI paradigms are useful frameworks to examine the location choice decision for offshoring of R&D activities by MNCs, my findings indicate that location choice for offshore R&D activities requires an evolutionary perspective linked with all these theories. Regions, countries, and firms evolve from their routines and previous bases to new stages by possessing new advantages (sometimes bypassing some stages of R&D and hence technology development). An evolutionary perspective of offshore location choice for R&D projects applied to the TCE, RBV, and OLI paradigms will help to explain why a certain location is chosen for R&D activities and also what types of R&D activities are offshored to particular countries. This extension to my framework can also enable researchers to examine the trade-offs between the OLI factors in location choice for offshore R&D activities between countries. Such a link between the evolutionary perspective and my framework will create new avenues for research to test longitudinal changes in the MNE's knowledge creation strategies, performance of different offshore R&D locations, and the impact on home country knowledge creation capacity.

A potential extension of this study would be to include outsourcing of R&D as well as offshoring of R&D, and to consider the impact of outsourcing R&D. A key issue to consider is the way in which outsourcing R&D affects the firm's offshore location choices. Further research is also needed on factors determining regional and global oriented R&D project location choice. Examination of knowledge transfer between global and regional oriented projects would establish a better picture of knowledge transfer from the center to offshore locations, and also reverse knowledge transfer between offshore R&D projects to the center itself.

Summary

This thesis addressed important strategic management and international business related questions. Using primary data sources, the thesis adopted a multi-level approach to examine questions related to the offshoring of R&D activities. The determinants of the location choice decision for offshoring of R&D activities by MNCs were examined in Chapter 5. Also the degree of innovativeness and routineness of the offshored R&D activities were investigated in that chapter. Even though the thesis has a few limitations that were identified in the earlier subsection, this research makes significant contributions to the academic literature.

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APPENDIX A

Survey Cover Letter

Dear Director or Manager,

You are being invited to take part on a research survey on “Offshoring of Research and Development (R&D) activities by Multinational Corporations”. Before you decide whether or not to take part, please let us highlight why the research is being undertaken.

As you aware, offshoring of high value added activities such as R&D has become a common feature of the contemporary business landscape, with many companies resorting to offshoring to increase quality, efficiency and more generally to deal with challenges of the rapidly changing and increasing competitive marketplace. This survey (which is part of a doctoral research project undertaken at the University of Sheffield) aims to shed light on the factors and determinants that affect location decision choice of R&D offshoring.

The industry in which your company operates is one of the few that have been carefully selected for the purpose of this survey and, therefore, your voluntary participation would make a valuable contribution to the success of this research project.

We would be very grateful if you could find the time to complete the online survey, or identify a suitable person in your company who could do so. The information you provide will be kept confidential and will be used for the purpose of research only. No individual company names or personnel will be identified and/or divulged. After the survey will be concluded, we will share the results of this study with you, so that you could see how your current R&D offshoring processes and decisions compare with the other companies sampled, on average.

Please do not hesitate to contact us in case you have questions concerning the questionnaire.

Thank you very much for your cooperation.

Best regards,

Assylbek Nurgabdeshov	Dr. Shlomo Tarba	Dr. Peter Rodgers
PhD student	Lecturer	Lecturer
Management School	Management School	Management School
University of Sheffield	University of Sheffield	University of Sheffield

Informed Consent Form

Introduction
This study attempts to investigate the factors and determinants of location choice decision of Research and Development (R&D) activities offshoring by Multinational Corporations.

Procedures
You will be asked to complete a questionnaire about your company's decision to offshore R&D activities. The questionnaire consists of 25 questions and will take approximately 15-20 minutes or less. This questionnaire will be conducted with an online Qualtrics-created survey.

Risks
There is not any risk for involvement in this study.

Benefits
After the survey will be concluded, we will share the results of this study with you, so that you could compare your results against the average of sample.

Participation
Participating in this study is completely voluntary. Even if you decide to participate now, you may change your mind and stop at any time. You may choose to not answer an individual question or you may skip any section of the survey. Simply click "Next" at the bottom of the survey page to move to the next question.

Questions about the Research
If you have questions about this research study, you can contact Assylbek Nurgabdeshov, PhD student, Management School, The University of Sheffield, 171 Northumberland Road, Sheffield, UK, +44 (0)114 222 3498, nurgabdeshov@sheffield.ac.uk

Questions about your Rights as Research Participants
If you have questions about your rights as a research participant, or wish to obtain information, ask questions or discuss any concerns about this study with someone other than the researcher(s), please contact the Dr. Shlomo Tarba, Lecturer, Management School, The University of Sheffield, 1 Conduit Road, Sheffield, UK, +44 (0)114 222 3307, s.tarba@sheffield.ac.uk
If you do not wish to participate, click the "x' in the top corner of your browser to exit.

I have read, understood, and printed a copy of, the above consent form and desire of my own free will to participate in this study. ☐ YES ☐ NO

Questionnaire

Section A: General questions

1) The location of your company or department: _______________ (country)
2) The location of the MNC's headquarter to which your company or department belongs: ______________________ (country)
3) The number of employees:
4) The number of R&D employees:
5) When was the company established? _______ year
6) Prior R&D offshoring experience of your company: _______ (years)
7) Prior offshoring experience of your company (independent of the type of activity): _________ (years)
8) The business field of your company:

Sectors					
☐	Aerospace and Defence	☐	Food Products	☐	Oil and Gas
☐	Biotechnology	☐	Motor Vehicles	☐	Ships and Boats
☐	Chemicals	☐	Metallurgy/ Mining	☐	Textiles
☐	Computers and Office machines	☐	Non-electrical machinery	☐	Telecommunication
☐	Electrical Machinery	☐	Paper and Printing	☐	Software and Computer Services
☐	Electronics	☐	Pharmaceuticals	☐	Wood Products
☐	Financial Services/ Banking	☐	Plastic and Rubber	☐	Other

Section B: The determinants of location choice (Captive offshoring)

9) Please identify one of the most significant R&D activities being offshored to foreign affiliate of your company. Other questions in this section will be based on the offshored R&D activity you have chosen.

10) The location of R&D activity offshored to foreign affiliate of your company _______________ (country)

11) At the time when your company decided to offshore R&D activity to foreign affiliate of your company, how important were the following factors in the decision process of country choice?

Please circle your answer	Very low	Low	Medium	High	Very high
a) Human Capital					
i) Availability of qualified R&D workers in a specific field of expertise relevant to your research fields	1	2	3	4	5
ii) Availability of qualified R&D workers, independent of their specific expertise	1	2	3	4	5
iii) Availability of qualified workers with postgraduate degree	1	2	3	4	5
b) Country Risk					
i) Political stability of the country	1	2	3	4	5
ii) Economic stability of the country	1	2	3	4	5
iii) Financial stability of the country	1	2	3	4	5
c) National Innovation System					
i) Information and communication infrastructure	1	2	3	4	5
ii) Local government policies, e.g. tax credits or subsidies	1	2	3	4	5
iii) The presence of R&D clusters	1	2	3	4	5
iv) The presence of high quality universities and research institutes	1	2	3	4	5
v) Intellectual property rights regime of the country	1	2	3	4	5

12) Please classify the R&D activity being offshored to foreign affiliate of your company.

a) *Core activity* – the activity which the company performs better than any other company and if the company will give this activity to an external party, it would be creating a competitor or dissolving itself.

b) *Essential activity* – the activity which is needed for sustain company's profitable operations and if not performed exceptionally well, can place the firm at a competitive disadvantage or even create a risk.

c) *Non-core activity* – the activity which supply no competitive advantage.

13) Please evaluate the characteristics of R&D activity offshored to foreign affiliate of your company.

Please circle your answer	Very low	Low	Medium	High	Very high
a) **Routiness**, i.e. the degree of repetitiveness and routineness of tasks, which can be specified in asset of rules.	1	2	3	4	5
b) **Interactivity**, i.e. a real time person-to-person information exchange, the degree of interaction between service provider and customer.	1	2	3	4	5
c) **Innovativeness**, i.e. the degree of innovation, new ideas and approaches	1	2	3	4	5

14) Considering the characteristics of R&D activity, how important were the following factors in the decision of location choice for offshoring of R&D activity to foreign affiliate of your company?

Please circle your answer	Very low	Low	Medium	High	Very high
a) Cost					
i) Comparably low costs of doing R&D activity in the country	1	2	3	4	5
ii) Comparably low wages of R&D workers	1	2	3	4	5
iii) Comparably low costs of establishing R&D centre in the country	1	2	3	4	5
b) Cultural difference					
i) Similar business mentality	1	2	3	4	5

ii) Similar business laws	1	2	3	4	5
iii) Common language	1	2	3	4	5
iv) Colonial ties or historical experience between home and host country	1	2	3	4	5
v) Economic or trade agreement between home and host country	1	2	3	4	5
d) The experience of company i) Prior R&D offshoring experience of your company in the country	1	2	3	4	5
ii) Prior offshoring experience(independent of the type of activity) of your company in the country	1	2	3	4	5
iii) Prior R&D offshoring experience of your company outside of the Headquarter country	1	2	3	4	5
e) Firm level factors **i)** Reputation of the firm	1	2	3	4	5
ii) Capability of provider in a specific field of expertise relevant to your research fields	1	2	3	4	5
f) The project level factors i) The speed of R&D project completion in the country	1	2	3	4	5
ii) The quality of completed R&D projects in the country	1	2	3	4	5

Section C: The determinants of location choice (Offshore outsourcing)

15) Please identify one of the most significant R&D activities being offshored to foreign non-integrated supplier. Other questions in this section will be based on the offshored R&D activity you have chosen.

16) The location of R&D activity offshored to foreign non-integrated supplier _______________ (country)

17) At the time when your company decided to offshore R&D activity to foreign non-integrated supplier, how important were the following factors in the decision process of country choice?

Please circle your answer	Very low	Low	Medium	High	Very high
a) Human Capital					
i) Availability of qualified R&D workers in a specific field of expertise relevant to your research fields	1	2	3	4	5
ii) Availability of qualified R&D workers, independent of their specific expertise	1	2	3	4	5
iii) Availability of qualified workers with postgraduate degree	1	2	3	4	5
b) Country Risk					
i) Political stability of the country	1	2	3	4	5
ii) Economic stability of the country	1	2	3	4	5
iii) Financial stability of the country	1	2	3	4	5
c) National Innovation System					
i) Information and communication infrastructure	1	2	3	4	5
ii) Local government policies, e.g. tax credits or subsidies	1	2	3	4	5
iii) The presence of R&D clusters	1	2	3	4	5
iv) The presence of high quality universities and research institutes	1	2	3	4	5
v) Intellectual property rights regime of the country	1	2	3	4	5

18) Please classify the R&D activity being offshored to foreign non-integrated supplier.

a) *Core activity* – the activity which the company performs better than any other company and if the company will give this activity to an external party, it would be creating a competitor or dissolving itself.

b) *Essential activity* – the activity which is needed for sustain company's profitable operations and if not performed exceptionally well, can place the firm at a competitive disadvantage or even create a risk.

c) *Non-core activity* – the activity which supply no competitive advantage.

19) Please evaluate the characteristics of R&D activity offshored to foreign non-integrated supplier.

Please circle your answer	Very low	Low	Medium	High	Very high
a) **Routiness**, i.e. the degree of repetitiveness and routineness of tasks, which can be specified in asset of rules.	1	2	3	4	5
b) **Interactivity**, i.e. a real time person-to-person information exchange, the degree of interaction between service provider and customer.	1	2	3	4	5
c) **Innovativeness**, i.e. the degree of innovation, new ideas and approaches	1	2	3	4	5

20) Considering the characteristics of R&D activity, how important were the following factors in the decision of location choice for offshoring of R&D activity to foreign non-integrated supplier?

Please circle your answer	Very low	Low	Medium	High	Very high
a) Cost i) Comparably low costs of doing R&D activity in the country	1	2	3	4	5
ii) Comparably low wages of R&D workers	1	2	3	4	5
iii) Comparably low costs of establishing R&D centre in the country	1	2	3	4	5
b) Cultural difference i) Similar business mentality	1	2	3	4	5
ii) Similar business laws	1	2	3	4	5

iii) Common language	1	2	3	4	5
iv) Colonial ties or historical experience between home and host country	1	2	3	4	5
v) Economic or trade agreement between home and host country	1	2	3	4	5
c) The experience of company i) Prior R&D offshoring experience of your company in the country	1	2	3	4	5
ii) Prior offshoring experience(independent of the type of activity) of your company in the country	1	2	3	4	5
iii) Prior R&D offshoring experience of your company outside of the Headquarter country	1	2	3	4	5
d) The firm level factors i) Reputation of the firm	1	2	3	4	5
ii) Capability of provider in a specific field of expertise relevant to your research fields	1	2	3	4	5
e) The project level factors i) The speed of R&D project completion in the country	1	2	3	4	5
ii) The quality of completed R&D projects in the country	1	2	3	4	5

Section D: The performance of knowledge transfer

21) To what extent can the knowledge transferred to vertically integrated affiliates or acquired firms located in an offshore market to your headquarter be characterized as …

Please circle your answer	No or little extent	Some extent	Moderate extent	Great extent	Very great extent
a) **Easy to codify**, i.e. information is often provided in blueprints, manuals, procedures, etc.	1	2	3	4	5
b) **Complex**, i.e. knowledge is about highly interdependent routines, individuals, technologies, etc.	1	2	3	4	5
c) **Specific**, i.e. knowledge in its context is about specific functional expertise.	1	2	3	4	5
d) **Available**, i.e. always available for and easy accessible by the new personnel in the company	1	2	3	4	5

22) To what extent can the knowledge transferred to non-integrated suppliers located in an offshore market to your headquarter be characterized as …

Please circle your answer	No or little extent	Some extent	Moderate extent	Great extent	Very great extent
a) Easy to codify, i.e. information is often provided in blueprints, manuals, procedures, etc.	1	2	3	4	5
b) Complex, i.e. knowledge is about highly interdependent routines, individuals, technologies, etc.	1	2	3	4	5
c) Specific, i.e. knowledge in its context is about specific functional expertise.	1	2	3	4	5
d) Available, i.e. always available for and easy accessible by the new personnel in the company	1	2	3	4	5

23) Please evaluate the degree of knowledge transfer to vertically integrated affiliates or acquired firms located in an offshore market to your headquarter.

Please circle your answer	Very low	Low	Medium	High	Very high
a) Basic research	1	2	3	4	5
b) Applied research	1	2	3	4	5
c) Product design	1	2	3	4	5
d) Field testing	1	2	3	4	5
e) Product development	1	2	3	4	5
f) Market research	1	2	3	4	5
g) Commercialization	1	2	3	4	5
h) Market testing	1	2	3	4	5
i) Technical Implementation	1	2	3	4	5

24) Please evaluate the degree of knowledge transfer to non-integrated suppliers located in an offshore market to your headquarter.

Please circle your answer	Very low	Low	Medium	High	Very high
a) Basic research	1	2	3	4	5
b) Applied research	1	2	3	4	5
c) Product design	1	2	3	4	5
d) Field testing	1	2	3	4	5
e) Product development	1	2	3	4	5
f) Market research	1	2	3	4	5
g) Commercialization	1	2	3	4	5
h) Market testing	1	2	3	4	5
i) Technical implementation	1	2	3	4	5

25) Please indicate the extent to which you agree or disagree with the following statements.

Please circle your answer	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
a) Your company is very satisfied with the overall benefits obtained from offshoring of R&D activities to vertically integrated affiliates	1	2	3	4	5
b) Your company is very satisfied with the overall benefits obtained from offshoring of R&D activities to non-integrated suppliers	1	2	3	4	5
c) Your company is very satisfied with the quality of the service received from vertically integrated affiliates in terms of consistency, timeliness and accuracy	1	2	3	4	5
d) Your company is very satisfied with the quality of the service received from non-integrated suppliers in terms of consistency, timeliness and accuracy	1	2	3	4	5
e) Offshoring of R&D activity to vertically integrated affiliates has allowed your company to concentrate own resources on core activities	1	2	3	4	5
f) Offshoring of R&D activity to non-integrated suppliers has allowed your company to concentrate own resources on core activities	1	2	3	4	5
g) By offshoring the R&D activity to vertically integrated affiliates has benefited from better access to skilled personnel	1	2	3	4	5
h) By offshoring the R&D activity to non-integrated suppliers has benefited from better access to skilled personnel	1	2	3	4	5
i) Your company has achieved the target level; of cost savings expected by offshoring of R&D activity to vertically integrated affiliates	1	2	3	4	5
j) Your company has achieved the target level; of cost savings expected by offshoring of R&D activity to non-integrated suppliers	1	2	3	4	5

APPENDIX B

Table 34: List of top MNCs investing in R&D

№	Company name	Industry	2009 R&D investment (£M)	2008 R&D investment (£M)	2007 R&D investment (£M)	2006 R&D investment (£M)	2005 R&D investment (£M)	Employees
1	ABB	Business support services	6,73	6,92	4,96	4,44	4,26	2021
2	Abbott Laboratories	Pharmaceuticals	4,11	3,76	3	2,3	3,42	1044
3	Abcam	Biotechnology	3,08	2,42	1,71	1,23	0,74	214
4	Acambis Research	Biotechnology	10,53	7,6	18,73	0,22	2,26	13
5	Actix International	Software	3,59	4,8	5,09	7,28	6,73	169
6	Acturis	Software	2,52	1,99	1,31			110
7	Adeptra	Business support services	1,79	1,35	1,54	1,14	1,14	116
8	Advanced Medical Solutions	Medical supplies	1,91	1,88	1,08	0,97	1,15	241
9	Aegis	Media agencies	4,2	2	1,1	0,2	3	15949
10	Aero Inventory	Aerospace	6,69					297
11	Aesica Pharmaceuticals	Pharmaceuticals	1,1	0,59	0,71	0,91	1,23	615
12	AFC Energy	Electrical components & equipment	0,93	1,29	0,65	0,31		24
13	Afton Chemical	Specialty chemicals	9,11	6,8	7,71	12,31	10,27	116
14	Aga Rangemaster	Durable household products	3,2	3,2	4,9	4,5	4,2	2656
15	Agilent Technologies	Electronic equipment	12,1	26,72	20,87	35,7	34,64	737
16	Airborne Systems	Defence	1,97	2,14	2,09	3,52	4,18	882
17	Airbus Operations	Aerospace	367	494	397	445	343	8175
18	Airvana	Telecommunications equipment	2,63	1,27	0,46	0,26		41
19	Akzo Nobel Decorative Coatings	Specialty chemicals	1,42	2,64	2,5	2,71	2,75	1034
20	Akzo Nobel Powder Coatings	Specialty chemicals	2,02	2,08	2,58	2,42	1,51	295
21	Albion Automotive	Commercial	1	0,58	0,58	0,41	0,55	334

		vehicles & trucks						
22	Alcatel-Lucent Submarine Networks	Telecommunications equipment	1,1	1	0,8	0,7	1,7	167
23	Alcoa	Aluminium	2,34	5,56	8,81	7,51	1,51	1942
24	Alere Technologies	Medical equipment	6,32	11,83	8,47	3,28		73
25	Alexander Dennis	Commercial vehicles & trucks	3,2	2,94	3,11	3,57		2143
26	Alexandra	Clothing & accessories	0,81	0,87	0,88	0	0	859
27	Alizyme	Biotechnology	11,23	31,14	18,33	15,75	6,27	19
28	Allen & Overy	Business support services	5,2	3,8	0	0	0	4599
29	Allergan	Pharmaceuticals	37,4	27,53	17,64	7,95	8,37	358
30	Allergy Therapeutics	Pharmaceuticals	5,3	16,3	25,34	9,56	5,62	374
31	Allocate Software	Software	1,97	0,94	0,89	0,78	0,96	130
32	Alphameric Timeweave	Software	1,96	3,56	4,66	4,33	2,88	218
33	Alstom	Industrial machinery	20,76	17,62	17,66	15,86	28,27	5059
34	Altair Filter Technology	Industrial machinery	1,96	0,58	0,37			126
35	Alterian	Software	5,55	4,19	2,98	2,49	2,18	324
36	Altro	Building materials & fixtures	1,56	1,72	1,34	1,2	0,94	617
37	Amarin	Biotechnology	11,05	7,79	7,5	10,19	5,15	26
38	Amcor Flexibles	Containers & packaging	1,43	1,67	1,4	1,38	2,03	866
39	Amdocs	Software	130,28	139,63	142,7	115,65	89,45	17244
40	Amgen	Biotechnology	127,06	130,92	102,35	96,78		489
41	Amino Technologies	Telecommunications equipment	7,48	4,96	3,26	3,46	2,81	154
42	Amphenol	Electrical components & equipment	1,06	0,98	0,87	0,81	0,87	324
43	Andor Technology	Electronic equipment	2,86	2,61	1,91	2	1,77	203
44	Anglo American	General mining	21,05	22,29	25,39	28,49	24,77	107000
45	Anglo Design	Electronic	4,28	4,88	5,85	4,28	2,03	611

		equipment						
46	Anite	Computer services	12,1	17,33	18,11	14,47	10,52	807
47	Ant	Software	2,48	2,43	2,23	2,12	1,96	52
48	Antenova	Business support services	1,23	1,27	1,04	0,98		43
49	Antisoma	Biotechnology	35,77	17,98	13,81	16,57	12,06	88
50	Antonov	Auto parts	2,74	3,12	2,26	1,19	1,5	24
51	AorTech International	Medical equipment	1,04	1,02	0,82	0,63	0,65	28
52	ApaTech	Medical supplies	2,67	1,44	1,27	0,97	0,95	91
53	Apertio	Telecommunicatio ns equipment	3,51	4,96	4,74	3,12	1,63	170
54	Apitope Technology (Bristol)	Biotechnology	1,27	0,36				1
55	AppSense	Software	3,45	3,15	2,31			168
56	ARC International	Semiconductors	9,87	7,69	6,74	6,53	8,21	193
57	Archimedes Pharma	Pharmaceuticals	13,45	17,06	9,71	6,72		105
58	Ardana Bioscience	Biotechnology	9,12	8,89	6,4	4,01	12,44	33
59	Ark Therapeutics	Biotechnology	15,56	16,46	14,64	13,02	13,94	147
60	ARM	Semiconductors	104,56	76,73	73,78	74,7	70,22	1723
61	Armour	Consumer electronics	2,45	2,5	1,56	0,46	0,29	305
62	Arrowpoint Technologies	Software	1,12					4
63	Arup	Business support services	12,6	10,39	6,94	6,29	5,34	10346
64	Ascent Investments	Electronic equipment	1,17	1,5	1,97	1,65	1,49	99
65	Ascribe	Software	5,84	3,38	2,82	1,86	0,99	271
66	Aspex Semiconductor	Semiconductors	1,14	1,2	1,94	1,3	1,74	21
67	Aspreva Pharmaceuticals	Pharmaceuticals	1	1,62	3,67	5,18	1,5	
68	Astellas Pharma	Pharmaceuticals	1,66	1,8	1,6	1	0,73	233
69	Astellas Pharma Europe	Pharmaceuticals	8,01	10	5,07	4,77	10,78	148
70	Astex Therapeutics	Biotechnology	0,92	5,81	11,66	3,89	12,59	72
71	Aston Martin	Automobiles	28,85	21,38	36,85	32,1	33,25	1460
72	AstraZeneca	Pharmaceuticals	2745,6 8	3119,0 8	3076,9 7	2405,7 2	2092,3 9	63900
73	Astrium	Telecommunicatio	10,81	10,16	9,33	8,25	8,22	2351

		ns equipment						
74	Atlantic Inertial Systems	Defence	1,75	0,87				268
75	Auburn Acquisitions	Auto parts	26,5	22,9	20,7	18,5	20,7	16675
76	Automation Partnership	Medical equipment	1,7	1,36	1,57	2,24	3,22	130
77	Autonomy	Software	76,48	55,46	42,9	33,97	13,58	1684
78	Avacta	Biotechnology	1,01	0,86	0,25	0,09		46
79	Avaya	Telecommunications equipment	9,94	9,53	11,74	11,62	10,75	784
80	Avdel	Industrial machinery	1,68	2,85	2,95	3,03	2,6	354
81	Avecia Holdings	Biotechnology	6,3	7,7	10,3	26,3	45,4	630
82	Aventis Pharma	Pharmaceuticals	44,92	40,42	11,22	8,85	12,73	840
83	Avery Weigh-Tronix	Industrial machinery	2,72	3,18	3,43	5,76	3,37	2039
84	AVEVA	Software	20,95	27,33	21,3	17,61	13,95	815
85	Aviagen	Farming & fishing	7,19	3,2	9,72	8,19	11,56	1388
86	Aviza Technology	Semiconductors	5,81	4,24	3,77	3,67	4,71	183
87	Avon Rubber	Diversified industrials	1,9	3,41	9,41	9,14	6,95	879
88	AVX	Electrical components & equipment	1,96	2,2	2,54	2,56	3,49	596
89	Axiom Systems	Software	1,88	1,92	1,84			81
90	Axis-Shield	Biotechnology	7,47	7,22	7,46	11,28	8,97	517
91	Babcock International	Business support services	1,5	0,7	0,3	0	0,2	16637
92	BAE Systems	Defence	234	213	176	162		94000
93	Baker Hughes	Oil equipment & services	19,19	11,6	10,2	9,19	9,49	3195
94	Bakkavor London	Food products	1,1	1,3	1,3	0	0	18635
95	Balfour Beatty	Heavy construction	4	4	3	4	4	42297
96	Bangleflame	Building materials & fixtures	2,67	2,9	2,53	1,07		1910
97	Barden	Industrial machinery	1,56	0,47				370
98	BASF	Commodity	2,98	2,16	2,78	2,74	3,08	362

		chemicals						
99	BAT	Tobacco	152	138	119	97	93	61053
100	Baxenden Chemicals	Specialty chemicals	0,94	0,93	0,97	0,95	0,92	211
101	Baxi	Building materials & fixtures	11,43	9,67	9,91	11,74	9,91	4348
102	Bayer	Medical supplies	48,33	38,26				701
103	Bayer CropScience	Specialty chemicals	6,44	6,78	5,68	7,12	6,98	501
104	BBA Aviation	Transportation services	1,2	1,6	1,5	10,7	10,8	9694
105	BBC	Broadcasting & entertainment	50,1	47,8	16,1	14,6	16,2	22861
106	Be Un	Internet	1,48	4,04				14
107	Becrypt	Software	1,84	1,29	0,92	0,7	0,75	
108	BEIG Topco	Food products	11,22	30,55	7,06			2306
109	Bentley Motors	Automobiles	229,6	104,9	79,1	106,5	106,9	3681
110	Bernard Matthews	Food products	2,03	2,33	3,23	2,22	2,6	4647
111	BFS	Food retailers & wholesalers	4,58	11,41	3,19	0	0	5641
112	BG	Integrated oil & gas	10	11	8	10	7	6079
113	BHP Billiton	General mining	96,6	151,09	104,65	47,06	20,44	40990
114	Biocompatibles International	Medical supplies	13,99	11,24	8,78	7,74	7,68	164
115	Biogen Idec	Biotechnology	10,12	7,17	7,6	6,57	6,05	162
116	Biomet	Medical equipment	3,57	3,34	3,4	2,7	2,37	743
117	Bionostics	Medical equipment	0,83	0,69	0,59	3,35	2,43	106
118	Bioquell	Medical equipment	1,38	1,34	1,15	1,04	1,21	366
119	Biotica Technology	Biotechnology	1,39	1,49	1,26	2,29	1,71	
120	BioVex	Biotechnology	4,16	4,59	4,98	6,74	5,93	30
121	Blinkx	Internet	2,8	2,14				53
122	Body Shop	Specialty retailers	2,2	2,1	2,1	5,76	5,1	2760
123	Boehringer Ingelheim	Pharmaceuticals	29,29	35,86	39,63	31,01	15,59	865
124	Bombardier Aerospace	Aerospace	78,18	58,67	9,86	10,26	16,5	5127
125	Bombardier Transportation	Transportation services	12,68	13,34	7,36	6,3	5,22	3440
126	Bond International	Software	4,99	4,63	4,43	2,6	2,01	486

	Software							
127	Borregaard Industries	Specialty chemicals	4,15	3,5	4,39	5,1	5,03	888
128	Bostik	Specialty chemicals	1,49	1,29	1,1	1,03	0,95	646
129	BP	Integrated oil & gas	363,49	368,44	350,49	244,6	310,86	85200
130	BPB	Building materials & fixtures	5,6	5,07	3,6	3	5,3	123
131	BPB United Kingdom	Building materials & fixtures	2,38	1,91	1,74	1,39	0,45	1676
132	Brady	Software	1,42	1,29	1,21			60
133	Braemore Resources	General mining	2,57	3,72	1,84	0		23
134	Brammer	Industrial suppliers	1,05	1,04	1,43	1,78	0,99	2325
135	Bright Things	Toys	0,84	0,35	0,65	2,71	1,23	9
136	Bristan	Building materials & fixtures	0,79	0,76	0,73	0,33	0,16	644
137	Bristol-Myers Squibb	Pharmaceuticals	55,49	56,01	66,21	32,42	29,11	1410
138	Britannia Pharmaceuticals	Pharmaceuticals	3,29	4,85	4,21	4,08	3,36	49
139	British Sky Broadcasting	Broadcasting & entertainment	63	53	43	20	6	14922
140	Britvic	Soft drinks	1,5	2	1,8	2	1,15	3036
141	Broadcom Europe	Semiconductors	9,87	21,61	18,4	6,88	4,82	162
142	BSS	Industrial suppliers	4,6	7,4	6,4	4,2	0,2	4970
143	BT	Fixed line telecommunications	1029	1119	1252	1119	727	101700
144	BTG	Biotechnology	27	21,6	10	9	8,1	292
145	Business Control Solutions	Computer services	1,05	1,18	1,17	0,7	0,9	74
146	Cadbury	Food products	72	64	59	69	58	45179
147	Cadence Design Systems	Computer services	1,02	0,37	0,87	0,8	0,83	144
148	Calsonic Kansei Europe	Auto parts	5,61	4,52	4,08	5,56	7,19	1529
149	Cambridge Broadband Networks	Telecommunications equipment	3,79	3,34	2,39	2,22	2,2	89
150	CA-MC Acquisition	Electronic	2,76	2,56	2,47	2,65	2,48	315

		equipment						
151	Cancer Research Technology	Pharmaceuticals	9,37		5,39	4,63	3,61	139
152	Cantono	Software	0,98	1,01	1,95	0,34	0,36	93
153	Capula	Computer services	1,9	2,77	1,39	1,15	1,93	180
154	Carclo	Specialty chemicals	1,1	1,1	1,2	1,2		996
155	Carefusion UK 232	Medical supplies	1	1,06	1,08			94
156	Carefusion UK 305	Medical equipment	4,99	4,73	5,47	5,57	5,67	281
157	Castledon	Aerospace	0,87	1,03	0,64	0,62	0,65	596
158	Catalent UK Swindon Zydis	Pharmaceuticals	4,67	4,19	5,21	3,65	3,28	593
159	Caterpillar Marine Power	Commercial vehicles & trucks	0,82	0,07	0,05	0,03		90
160	CDT	Electrical components & equipment	8,58	6,95	5,11	6,18		157
161	CE Electric	Multiutilities	1,3	1,9	2,8	3,9	0,5	2489
162	CellCentric	Biotechnology	1,07	0,56	0,54	0,13	0,11	8
163	Celltech R&D	Business training & employment agencies	46,6	50,8	44	52,6	90,1	634
164	Celsis International	Medical equipment	1	0,95	0,97	0,36	0,44	215
165	Celtic Aerospace Ventures	Aerospace	1,56	0,17				587
166	Celtic Pharma Development	Biotechnology	1,66	3,78	4,34			13
167	Centaur Media	Publishing	0,9	0,7	1	1	1,2	695
168	Centrica	Gas distribution	29	2	26	75	75	34125
169	Ceres Power	Renewable energy equipment	5,36	4,18	3,85	2,36	1,77	75
170	Chalkfree	Electronic equipment	9,48	6,17	3,67	2,08	1,52	797
171	Chanel	Broadline retailers	1,95	2,7	2,32	2,3	2,46	1188
172	Channel Four Television	Broadcasting & entertainment	6,1	11,7	12,5	12,5	12,1	696
173	Character	Toys	2,61	4,86	1,87	1,27	1,14	161
174	Charter International	Industrial machinery	22,2	18,6	9,6	9,1	7,5	12451

175	Chemring	Defence	9,2	5,9	5,4	3,22	3,75	3379
176	Chemtura	Specialty chemicals	4,17	3,41	2,82	2,67	2,5	94
177	Chevron	Exploration & production	14,1	12,8	3,5	2,2	1,09	
178	China Eastsea Business Software	Software	0,92	0,4	0,03	0,01		380
179	Chloride	Electrical components & equipment	6,8	6,41	5,02	4,65	4,53	2407
180	Chroma Therapeutics	Biotechnology	10,07	11,64	7,77	6,23	4,44	59
181	Ciboodle	Software	2,81	2,03	1,81	1,93	1,84	197
182	Cisco Systems	Telecommunications equipment	20,12	23,01	21,55	18,31	21,96	2034
183	Cisco Systems (Scotland)	Computer services	4,74	3,52	3,21			40
184	Citrix Systems (Research and Development)	Software	15,15	12,74	10,95			246
185	Civil Aviation Authority	Transportation services	1,31	1,33	1,8	1,69	2,01	982
186	Clarity Commerce Solutions	Software	4,91	3,56	3,81	1,2	1,6	169
187	Claverham	Aerospace	9,29	9,55	2,7	1,34	0,73	313
188	ClearSpeed Technology	Semiconductors	5,7	6,43	6,08	4,65	2,5	65
189	Clearswift Systems	Software	3,8	3,68	4,38	4,67	4,41	180
190	Clinical Computing	Software	1,34	1,61	1,07	0,99	0,88	41
191	Clinical Solutions	Software	3,02	2,25	2,31	2,66		155
192	Clipper Windpower	Alternative electricity	14,99	13,33	6,24	4,35	3,15	749
193	CML Microsystems	Semiconductors	3,38	4	3,97	4,74	5,12	169
194	CNH	Commercial vehicles & trucks	20,55	22,98	23,99	26,47	18	980
195	Cobham	Aerospace	88,4	70,6	55,2	49,3	42,9	12044
196	Cochlear Research and Development	Medical equipment	7,11	0,8	3,94	3,78	2,17	63
197	CODA GB	Computer services	4,15	4,9				310
198	Cognis	Specialty	0,83	0,97	1,22	1,53	1,41	162

		chemicals						
199	Cognos	Software	2,31	2,39	3,16	3,27	3,34	310
200	Coherent Scotland	Electronic equipment	2,45	1,75	1,19	1,16	1,31	79
201	Cohort	Defence	7,08	5,5	1,94	0	0	645
202	Colgate-Palmolive	Personal products	0,81	0,81	0,76	0,79	0,91	151
203	Compair	Industrial machinery	1,67					381
204	Complinet	Publishing	0,79	0,38				196
205	Concateno	Health care providers	1,51	0,31	0			338
206	Concurrent Technologies	Computer hardware	3,25	2,03	1,52	1,34	1,18	104
207	Connaught	Business support services	1,9	1,3	1,85	0,94	0,25	8354
208	Consilium	Software	1,31	1,27	1,18	0,94	0,75	87
209	Consort Medical	Medical supplies	3,53	4,32	4,22	3,78	3,18	1250
210	Controlled Therapeutics	Pharmaceuticals	1,99	1,79	2,41	1,8	<0.005	66
211	Cookson	Diversified industrials	34,7	30,7	23,1	23,8	22,3	14985
212	Cooper Security	Electrical components & equipment	1,13	1,12	1,33	1,76	1,62	108
213	Cooper Tire & Rubber	Tyres	1,87	1,88	1,91	1,83	1,62	1007
214	Corac	Industrial machinery	2,43	2,54	1,55	1,12	0,97	35
215	Corin	Medical equipment	2,97	2,59	2,54	2,5	2,05	322
216	Crane	Industrial machinery	1,31	1,3	1,75	1,5	1,61	484
217	Craneware	Software	2,19	1,9	0,21	0	0,16	117
218	Cray Valley	Specialty chemicals	0,92	0,84	0,87	1,07	1,23	121
219	Croda International	Specialty chemicals	21,1	17,6	14,1	14,6	8,9	3543
220	Crown	Containers & packaging	17,4	16,6	17,4	20	17,2	3443
221	CSR	Telecommunications equipment	103,79	94,59	87,27	67,69	37,37	1167

222	Cummins	Auto parts	6,19	8,23	7,44	5,99		2913
223	Cummins Power Generation	Industrial machinery	2,25	1,84	1,19	0,91	2,06	621
224	Cummins Turbo Technologies	Auto parts	12,94	13,17	11,43	9,52	6,73	1117
225	Cyan	Semiconductors	1,53	1,95	1,49	0,42	0,5	30
226	Cybit	Transportation services	1,34	0,84	0,41	0,16	0,01	136
227	Cytec Engineered Materials	Specialty chemicals	0,89	0,55	0,37	0,2	0,34	214
228	Daily Mail and General Trust	Publishing	16,5	18,7	14	10,5	0	16038
229	Dairy Crest	Food products	7,8	3	2,9	1,5	2,2	7247
230	Datacash	Financial administration	0,87	0,45	0,23	3,27	0	363
231	Datong	Electronic equipment	1,84	1,45	1,36	1,04	0,84	94
232	Dawson	Business support services	3,3	1,7	0,6	0,1	0,1	2881
233	De Beers	Specialty retailers	2,8	8,04	9,85	10	10,49	447
234	De La Rue	Business support services	12,2	14,7	22,8	22,7	13,7	3946
235	Debenhams	Broadline retailers	6,3	4,5	5,3	11,3	0	27766
236	Dechra Pharmaceuticals	Pharmaceuticals	4,22	3,74	3,33	1,38	1,33	1012
237	Delcam	Software	9,2	8,79	7,83	7,29	6,51	518
238	Delphi Diesel Systems	Auto parts	37,36	23,16	18,51	16,65	17,12	3087
239	Denso Manufacturing	Auto parts	3,1	3,04	1,94	2,41	2,61	887
240	DePuy International	Medical equipment	18,88	17,58	20,64	20,4	14,68	835
241	Devro	Food products	5,98	5,16	4,49	4,84	4,15	2143
242	Diageo	Distillers & vintners	17	17	17	18	16	24270
243	Dialight	Electrical components & equipment	4,64	3,1	2,88	3,04	5,34	936
244	Dialog Semiconductor	Semiconductors	26,78	23,63	19,71	18,56	24,97	310
245	Dimension Data	Computer services	1,67					10915
246	Diodes Zetex Semiconductors	Semiconductors	6,92	6,19	6,18	6,22	6,39	425

247	Distribution Technology	Software	2,4	1,64				71
248	Diversey	Specialty chemicals	1,32	1,23	1,38	2,07	2,26	877
249	Diversey Equipment	Industrial machinery	1,89	1,31	1,25	1,18	0,86	71
250	Domino Printing Sciences	Electronic equipment	11,66	13,72	11,33	10,94	8,3	2070
251	Doncasters	Aerospace	4,1	7,3	2,8	2,55	2,48	5621
252	Doosan Babcock Energy	Industrial machinery	5,95	4,9	3,52	2,6	2,83	5166
253	DRS Data & Research Services	Computer services	3,06	3,26	2,38	2,06	1,72	215
254	Druck	Electronic equipment	4,94	5,22	5,07	3,29	3,14	607
255	DS Smith	Containers & packaging	1,8	1,2	1,1	1	1,1	10776
256	DSG International	Specialty retailers	14,1	1,1	7,8	7,6	12,1	38916
257	Dunlop Aircraft Tyres	Aerospace	0,94	0,36	0,76	0,63	0,56	333
258	Dupont Teijin Films	Specialty chemicals	3,14	3,09	3,04	3,24	3,41	373
259	Dyson	Specialty chemicals	1,03	3,47	3,29	5,16	3,97	646
260	Dyson James	Durable household products	49,13	52,35	50,92	35,55	19,42	2461
261	E.ON	Conventional electricity	10	14	8	6	5	17033
262	e2v Technologies	Electronic equipment	11,45	16,03	14,09	11,33	5,37	1666
263	EADS Defence and Security Systems	Defence	6,16	7,19	3,24	2,19	0,79	817
264	Eagle-I	Transportation services	0,92	0,53	0,35	0,18	0,11	30
265	Eaton	Industrial machinery	2,35	1,28	0,48	2,86	2,05	1054
266	Eaton Aerospace	Aerospace	5,89	6,46	4,28	7,43	8,76	1303
267	Eaton Electric	Electrical components & equipment	0,88	1,87	1,89	2,47	0,15	773

268	Ebiquity	Media agencies	0,98	0,39	0,63	0,83	0,76	255
269	ECO Animal Health	Pharmaceuticals	3,88	4,58	0,02	0,07		118
270	EDF Energy	Multiutilities	9,7	6,3	7	4,1	3,8	14058
271	Edwards	Industrial machinery	21,1	28,2	22,2			2939
272	Effem	Food products	22,76	21,84	21,16	22,41	26,32	4803
273	Eg solutions	Computer services	1,09	1,23	1,36	0,81	0,29	38
274	Eidos	Toys	62	72,2	68,5	57,4	21,07	987
275	Eisai Europe	Pharmaceuticals	151,13	106,07	71,44	40,36	38,39	968
276	Eleco	Building materials & fixtures	2,9	2,93	1,96	1,28	1,25	605
277	Electronic Arts	Toys	33,84	36,11				639
278	Electronic Arts	Software	1,6	3,05	4,21	6,08	7,59	28
279	Electronic Data Processing	Computer services	1,04	1,19	1,34	1,46	1,6	86
280	Elekta	Medical equipment	10,82	10,28	9,47	7,51	7,22	464
281	Element Six	Industrial machinery	3,15	2,94	3,11	2,91	2,83	56
282	Elementis	Specialty chemicals	5,9	4,6	3,7	4,4	6,2	1341
283	Eli Lilly and Company	Pharmaceuticals	130,21	139,66	107,05	107,03	110,15	1434
284	Emrise Electronics	Electronic equipment	1,66	1,2	0,74	0,56		165
285	EMS Satcom	Electronic equipment	1,27	0,8	1,51	0,92	1	34
286	Energetix	Industrial machinery	1,46	2,28	1,12	0,73	0,42	41
287	Enfis	Electrical components & equipment	1,4	1,08	1,24	0,75	0,62	17
288	Enigma Diagnostics	Biotechnology	1,16	1,92	2,31	0,94	0,39	24
289	Enodis	Industrial machinery	14,9	14	11,7	10,1	14,3	7029
290	Enrichment Technology	Industrial machinery	18,6	12,84	12,01	14,13		1743
291	Environmental Recycling Technologies	Waste & disposal services	1,08	0,63				5

292	Equisys	Software	0,99	0,88	0,75	0,73	0,73	50
293	Ericsson Services	Mobile telecommunications	0,87	3,23	0	0	0	1115
294	Ericsson Television	Telecommunications equipment	13,4	11,54	7,44	9,59	8,76	408
295	Esso	Integrated oil & gas	28,2	23,7	43,9	40,1	35,1	6403
296	e-Therapeutics	Biotechnology	1,69	0,93	1,07			16
297	Evolution Studios	Toys	3,04	2,15	1,86	1,9	1,65	0
298	Evolving Systems	Software	1,26	0,64	0,47	0,48	2,13	69
299	Experian	Business support services	27,87	27,25	37,77	29,1	24,15	14931
300	Expro Holdings UK 3	Oil equipment & services	27,16	24,66	13,26	5,42	2,41	4297
301	F G Wilson	Industrial machinery	5,23	3,88	3,62	4,92	5,52	3073
302	Fair Isaac	Software	1,34	1,93	0,58	2	2,54	67
303	Fair Isaac Services	Software	1,2	1,06	0,52	0,85	0,62	211
304	Feedback	Electronic equipment	0,96	1,13	1,21	0,66	0,78	82
305	Fenner	Industrial machinery	1,6	1,8	1,7	1,9	2,1	3874
306	Fernau Avionics	Electronic equipment	1,33	0,97	0,95	0,7	1	86
307	FFastFill	Software	3,1	4,14	0,96	0,66	1,32	128
308	FFEI	Electronic equipment	3,99	3,06	5,5	5,42	4,61	154
309	FGP Topco	Transportation services	18	28	9	18,67	27	12053
310	Fiberweb	Industrial suppliers	7,7	7,1	7,4			1936
311	Fidessa	Software	23,5	20,73	20,51	12,27	10,53	1442
312	Filtronic	Telecommunications equipment	2,25	6,76	15,64	27,65	31,08	233
313	Findel	Specialty retailers	3,14	4,19	5,26	0	0	3160
314	Finsbury Food	Food products	1,49	1,49	0	0	0	2790
315	Fisons	Pharmaceuticals	4,84	21,33	15,07	5,82	8,81	283
316	Focus Solutions	Software	2,08	1,55	0,86	0,42	0,57	88
317	Ford Motor	Automobiles	313	415	408	348	355	11107

318	Forensic Science Service	Business support services	5,4	3,53	4,42			1972
319	Forest Laboratories	Pharmaceuticals	1,59	1,97	4,6	2,45	1,63	95
320	Fort Dodge Animal Health	Farming & fishing	1,03	1,08	1,32	0,95	0,98	69
321	Fortent	Business support services	2,36	2,41	2,09	2,3	2,14	71
322	Freescale Semiconductor	Semiconductors	2,78	5,16	6,25	6,62	6,52	549
323	FremantleMedia	Broadcasting & entertainment	1,17	0	0	0	0	602
324	Frontier Silicon	Consumer electronics	5,96	8,84	10,08	6,21	2,31	125
325	FTSA	Business support services	0,82	0,76	1,13			295
326	Fuchs Lubricants	Specialty chemicals	0,92	0,95	0	0,92	0,87	266
327	FUJIFILM Imaging Colorants	Specialty chemicals	10,25	10,13	9,37	6,21		211
328	FUJIFILM Sericol	Specialty chemicals	3,5	3,31	2,37	1,91	1,26	478
329	Fujitsu Laboratories of Europe	Telecommunications equipment	4,4	3,78	3,73	4,09	4,04	35
330	Fujitsu Services	Computer services	11,2	23,4	19,1	11,3	40,6	18722
331	Fujitsu Telecom	Telecommunications equipment	15,36	28,69	36,52	32,2	15,14	736
332	G4S	Business support services	14,2	11,3	5,6	1,4	1,4	592964
333	Gallaher	Tobacco	6	6	7			1580
334	Games Workshop	Toys	2,99	3,1	4,34	4,26	4,28	2285
335	Gas Turbine Efficiency	Industrial machinery	4,94	4,32	1,99	0,43	0,06	125
336	GE Aviation Systems	Aerospace	77,07	74,45	78,83			2855
337	GE Aviation Systems Aerostructures	Aerospace	1,15	0,65				933
338	GE Fanuc Intelligent Platforms	Electronic equipment	3,74	3,29	2,48	2,23	1,59	60
339	GE Healthcare	Medical equipment	51,07	45,85	54,09	43,8	85,71	1509
340	GE Healthcare UK	Biotechnology	4,85	4,67	6,29	3,79	6,63	173

341	GE Intelligent Platforms	Electronic equipment	6,57	7,13	7,42	4,85	4,75	229
342	GE Medical Systems Oxford	Medical equipment	1,66	0,57	0,31	0,52	0,43	39
343	General Dynamics	Defence	3,67	2,78	2,16	1,48	0,93	1435
344	Generics	Pharmaceuticals	8,94	8,49	11,21	41,9	14,34	224
345	Genetix	Medical supplies	2,48	2,26	1,77	1,29	1,08	181
346	Gen-Probe Life Sciences	Biotechnology	2,74	2,07	1,78	1,74	1,55	225
347	Genus	Biotechnology	28,6	18,4	17,7	13,12	8,54	2118
348	Genzyme	Pharmaceuticals	4,41	7,87	7,54	6,56	4,51	462
349	Genzyme Therapeutics	Medical supplies	17,06	8,49	4,47			165
350	Givaudan	Specialty chemicals	5,31	3,62				667
351	GKN	Auto parts	95	97	83	75	88	35315
352	Gladstone	Software	0,81	0,52	0,1	0	0	116
353	GlaxoSmithKline	Pharmaceuticals	3629	3314	3146	3435	3134	98854
354	Glen Electric	Durable household products	21,74	20,08	16,31	14,68	13,76	5525
355	Globo	Software	5,06	4,15	1,25			79
356	Gooch & Housego	Electrical components & equipment	2,79	2,7	1,9	0,95	0,87	453
357	Goodrich Controls	Aerospace	40	39	39,5	56,6	52,2	3247
358	Google	Internet	18,99	10,14	4,49	0	0	772
359	Gresham Computing	Software	1,13	2,07	1,56	1,74	1,61	100
360	Group NBT	Internet	0,85	0,42	0,42	0,39	0,19	284
361	GW Pharmaceuticals	Pharmaceuticals	6,81	10,43	12,51	13,1	10,28	110
362	H J Heinz	Food products	7,7	8	6,8	5,6	6,37	2102
363	H J Heinz Frozen & Chilled Foods	Food products	1,7	0,3	0,3	0,3	0,2	925
364	Halma	Electronic equipment	21,37	22,91	18,68	15,32	14,21	3689
365	Hampson Industries	Aerospace	1,66	1,35	1,61	8,5	4,83	1692
366	Hamworthy	Industrial machinery	4,07	2,91	2,04	1,48	1,25	1026
367	Happold	Business support services	3,46	3,08	1,79			1607

368	Haptogen	Biotechnology	1,04	0,98	0,95	0,73	0	24
369	Harman	Electronic equipment	6,16	5,53	5,2	4,89	4,92	522
370	Haynes Publishing	Publishing	1,94	0	0	0	0	271
371	Hazlewood Grocery	Food products	0,94	1,13	1,24	1,29	1,26	1439
372	Herman Miller	Furnishings	3,11	2,85	2,13	1,55	1,82	293
373	Hewlett-Packard	Computer hardware	35,66	31,22	30,56	30,79	26,44	5911
374	Hexion Specialty Chemicals	Specialty chemicals	0,94	1,08	1,05	0,74	0,74	165
375	Hikma Pharmaceuticals	Pharmaceuticals	10,43	13,73	11,98	11,33	10,22	4880
376	Hill & Smith	Industrial machinery	0,8	2,1	1,2	0,19	0,08	3232
377	Hogg Robinson	Business support services	5,1	3,3	1,49	1,57	0,82	5319
378	Holtzbrinck Publishers	Publishing	1,54	0,84	1,22	1,36	1,01	9018
379	Homefield Pvt	Specialty chemicals	0,93	0,3	0,35	0,3	0,5	1529
380	Honda of the UK Manufacturing	Automobiles	0,99	0,39	3,74	6,28	0	4570
381	Honeywell Analytics	Electronic equipment	1,32	1,28	1,48	1,9	1,88	164
382	Honeywell Control Systems	Electronic equipment	1,6	1,92	2,66	3,2	4,57	2330
383	Honeywell Security	Business support services	1,49	1,73	1,66	0,43	0,35	190
384	Hornby	Toys	1,22	1,43	1,23	0,84	0,1	239
385	HP Enterprise Services	Computer services	63,49	75,48	77,56	75,05	0	14101
386	HR Wallingford	Business support services	1,39	0,86	0,53	0,11	0,1	319
387	Hunter-Fleming	Pharmaceuticals	2	0,78	1,1	0,57	1,49	8
388	Hunting	Oil equipment & services	0,9	0,2	0,7	1	0,7	1993
389	Huntleigh Healthcare	Medical equipment	5,11	4,92	5,07	6,22	5,36	1004
390	Hypercom	Electronic equipment	0,97	1,33	1,57	1,59	2,08	73

391	Hypercom EMEA	Electronic equipment	1,21	1,53	0,77	1,27	0,76	67
392	i2	Software	7,62	6,12	5,57	5,22	5,33	198
393	ICEM	Software	3,64	4,42	3,62	2,7	2,72	5
394	IdaTech	Electrical components & equipment	5,74	3,22	0,54			97
395	Illumina Cambridge	Medical equipment	19,02	16,07	14,8	9,2	3,97	120
396	Imagination Technologies	Semiconductors	35,37	31,11	26,87	23,42	20,65	590
397	i-mate	Telecommunications equipment	3,17	3,44	1,1	0,34		170
398	IMERYS Minerals	General mining	3,53	4,62	5,73	3,35	3,85	1175
399	IMI	Industrial machinery	39,1	38,2	30,7	34,1	29,4	13689
400	Immune Targeting Systems	Biotechnology	1,85	1,31				
401	Immunodiagnostic Systems	Medical equipment	3,7	3,81	2,69	0,71	0,81	241
402	ImmuPharma	Biotechnology	3,84	2,74	1,91	0,76	0,97	7
403	Impellam	Business training & employment agencies	1,1	1,92	0,8	0	0	2471
404	Imperial Chemical Industries	Specialty chemicals	21	94	153	147	146	1125
405	in4tek	Software	1	1,17	0,85	0,95	0,85	53
406	IndigoVision	Computer services	2,26	1,77	1,49	1,38	1,45	100
407	INEOS	Specialty chemicals	52,42	59,17	76,32	69,39	17,06	11949
408	INEOS Fluor	Specialty chemicals	1,82	2,68	4,44	2,48	1,58	220
409	Infermed	Software	1,02	0,83	0,61	0,64	0,53	
410	Infor Global Solutions	Software	2,51	2,64	2,67	4,71	3,97	78
411	Infor Global Solutions (Farnborough)	Software	6,56	6,67	3,33	7,98	8,9	102
412	Inmarsat	Mobile telecommunications	14,55	4,77	5,14	2,11	11,46	1244
413	Innospec Ltd	Specialty	6,05	5,06	4,35	3,42	3,99	381

		chemicals						
414	Innovation	Software	8,67	7,54	3,14	2,28	2,72	2310
415	Innovia Films	Specialty chemicals	5,04	5,57	5,65	3,95	1,19	1415
416	Innovision Research & Technology	Semiconductors	1,57	1,59	1,74	0,63	0,39	53
417	Intec Telecom Systems	Software	16,44	14,88	15,26	15,66	16,51	1716
418	Intel	Semiconductors	16,32	16,47	10,97	16,25	9,89	956
419	Intelek	Telecommunications equipment	2,87	2,18	1,95	1,87	2,3	418
420	Intelligent Energy	Electrical components & equipment	5,9	5,67	3,78	6,25	6,78	101
421	Intercede	Software	1,47	1,33	1,04	1,02	0,89	54
422	International Flavours & Fragrances	Specialty chemicals	7,24	7,09	6,72	6,97	6,33	715
423	International Paint	Specialty chemicals	9,8	6,5	4,9	5	4,6	991
424	International Power	Conventional electricity	9	11	5	3	3	3936
425	International Rectifier	Semiconductors	2,85	2,44	4,3	5,04	5,35	84
426	Invensys	Software	130	114	100	89	110	20357
427	INVISTA Textiles	Clothing & accessories	5,46	7,69	6,44	7,93	4,59	912
428	Invotec	Electrical components & equipment	1,97	2,12	1,83	2,22	2	319
429	Invu	Software	0,89	0,83	0,46	0,44	0,46	65
430	ip access	Electronic equipment	2,44	2,65	3,25	4,5	3,16	179
431	Ipsen	Pharmaceuticals	0,83					62
432	Ipsen Biopharm	Pharmaceuticals	9,02	9,74	16,38	13,74	8,09	252
433	Ipsen Developments	Pharmaceuticals	23,97	25,36	29,24	26,63	22,04	124
434	IQE	Semiconductors	2,48	1,78	1,57	0,62	0,5	315
435	IR Newport	Semiconductors	7,06	2,57	3,74	3,07	0,81	418
436	Iris Software	Software	13,75	9,37				1330
437	IS Pharma	Pharmaceuticals	2,64	0,83	0,45	0,1	0,09	21
438	iSOFT Applications	Software	2,42	0	0	0	0	5

439	Isotrak	Computer services	1,72	0,94	0,93	0,92	1,03	64
440	ITIS	Telecommunications equipment	1,53	1,8	1,83	1,59	1,06	207
441	ITM Power	Renewable energy equipment	3,58	3,92	3,37	1,61	0,93	61
442	ITRS	Software	0,84	0,67	0,47	0,36	0,34	54
443	ITV	Broadcasting & entertainment	13	20	22	4	0	4519
444	Jagex	Toys	1,74	1,49			0,52	370
445	Jaguar Cars	Automobiles	180,8	192,8	185,4	193,7	226,1	7268
446	James Cropper	Paper	1	0,93	0,96	0,78	0,97	625
447	James Fisher	Transportation services	3,06	1,84	2,96		0	1432
448	James Halstead	Building materials & fixtures	1,55	1,71	1,68	1,59	1,62	777
449	Janssen-Cilag	Pharmaceuticals	54,37	59,59	52,83	36,83	39,34	826
450	Jarvis	Business support services	2,8	1,6	0	0	0	2930
451	Jas Bowman	Food products	1,01	0,89	0,99	1,3	1,17	198
452	JCB Service	Commercial vehicles & trucks	34,6	29,9	32,7	27,92	26,79	7618
453	Jeyes	Nondurable household products	2,6	2,31	2,36	1,92	2,19	1684
454	Job Partners	Software	1,21	1,1	1,85	1,74	1,24	110
455	John Lewis	Broadline retailers	30,8	38,2	23,3	21,3	21,8	70000
456	John Menzies	Business support services	3,8	1,4	0,4	0,5	0	17599
457	John Wyeth & Brother	Pharmaceuticals	60,33	42,6	41,86	39,1	32,17	1140
458	Johnson & Johnson Consumer Services	Business support services	7,16	7,43	7,76	0,56	0,31	292
459	Johnson Matthey	Specialty chemicals	87,2	82,5	68,1	63,5	58,8	8575
460	K3 Business Technology	Software	1	0,37	0,23	0	0,47	320
461	KBC Advanced Technologies	Oil equipment & services	2,8	1,8	2,12	2,43	2,6	306
462	KCOM	Fixed line telecommunication	1,77	1,61	2,87	3,23	2,59	2094

		s						
463	Kelda Eurobond	Water	2,53	0,8	0,9	0,9	0,9	3374
464	Kemble Water	Water	3,5	3,5	4,1	3,6	5,3	5095
465	KemFine	Specialty chemicals	1,39	1,53	1,4	1,52	0,55	233
466	Kendle Clinical Development Services	Business support services	3,81	3,04				278
467	Kenwood	Durable household products	4,09	3,49	3,15	2,66	0,73	254
468	Kerry Foods	Food products	2,32	2,71	2,88	3,41	2,23	4128
469	Kerry Ingredients	Food products	7,09	6,28	5,37	4,84	5,28	1721
470	Kesa Electricals	Specialty retailers	14,5	13,68	8,8	3,4	0	27360
471	Kewill	Software	6,77	6,69	5,92	3,68	2,88	598
472	Kidde Graviner	Electronic equipment	1,42	0,96	0,61	0,68		176
473	Kimberly-Clark Europe	Nondurable household products	44,69	44,07	10,11	6,5	6,3	402
474	Knorr-Bremse Rail Systems	Transportation services	0,9	0,63	0,8	1,27	1,58	327
475	Kodak	Recreational products	4,7	4,1	4,3	6,9	8,6	1516
476	Kofax	Software	18,1	17,4	15,3	12,6	9,89	1147
477	Kohler	Durable household products	6,23	6,31	6,12	5,79	5,68	1133
478	KPMG Europe	Business support services	27,54	35,54	10	3	6	20897
479	Kraft Foods	Food products	2,17	3,2	2,83	3,67	3,48	1192
480	Lagan Capital	Software	2,31	0,78	1,42		0	54
481	Laird	Electrical components & equipment	42,8	39	25,1	20,9	16	11765
482	Land Rover	Automobiles	313,9	227,3	203,7	253,9	231,8	7841
483	Latchways	Industrial suppliers	1,09	1,04	1,02	1,03	0,8	241
484	Lectus Therapeutics	Biotechnology	2,82	4,47	3,22	1,13	0,42	26
485	Lend Lease	Heavy construction	0,94	2,22	0	0	0	4029
486	Lifescan Scotland	Medical equipment	19,53	22,75	24,26	24,38	37,04	1189
487	Limagrain	Farming & fishing	4,04	4,08	2,68	1,99	1,99	201

488	Linde Material Handling	Industrial machinery	6,05	5,42	4,03	4,43	4,1	731
489	Linn Products	Consumer electronics	1,75	2,53	3,05	3,89	3,37	164
490	Linx Printing Technologies	Electronic equipment	2,97	3,5	4,14	3,9	3,65	212
491	Lipoxen	Pharmaceuticals	2,45	3,78	2,36	1,72	0,79	23
492	Logan Teleflex	Industrial machinery	1,22	0,87	0,39	0,16	0,07	140
493	Logica	Computer services	22,7	17	21,7	40,2	31,1	39501
494	Logon2 ASP	Software	3,54					38
495	Lombard Medical Technologies	Medical supplies	4,98	7,53	6,37	4,79	3,16	64
496	Lombard Risk Managment	Software	1,14	2,44	2,36			158
497	Lonza	Pharmaceuticals	1,32	0,68	0,35			609
498	Lotus	Automobiles	15,84	10,85	5,62	5,28	3,92	1256
499	Low & Bonar	Building materials & fixtures	3,7	3,5	3,1	2	1,65	2071
500	Lubrizol	Specialty chemicals	34,22	31,55	30,2	26,74	24,09	385
501	Lucite International	Specialty chemicals	8	9	9	9	9	1843
502	Luxfer	Industrial machinery	3,2	3,5	3	3,7	4,1	1440
503	Macarthys Laboratories	Pharmaceuticals	0,8	0,36	0,42	0,32	0,27	469
504	MacDermid	Specialty chemicals	1,67	1,5	1,5	1,46	1,38	92
505	Macquarie UK Broadcast	Broadcasting & entertainment	1,41	1,99	2,5	0	0	2349
506	Marks & Spencer	Broadline retailers	56,9	118,8	65,1	46,2	10,7	76267
507	Marshalls	Building materials & fixtures	2,83	3,67	4,08	3,78		2464
508	Martin Dawes Systems	Computer services	5,05	3,84	2,74	2,17	1,5	303
509	Martin-Baker (Engineering)	Aerospace	6,79	6,78	8,41	7,75	4,43	743
510	MBDA	Defence	12,8	9,1	12,2	6,4	7,7	2563

511	McBride	Nondurable household products	6,6	5,9	5,2	4	4,5	5005
512	McCain Foods	Food products	1,66	1,49	1,66	1,59	1,77	1443
513	McNeil Healthcare	Pharmaceuticals	2,73	1,79	5,92	6,85	6,5	0
514	Mears	Business support services	0,79	0,5	0,23	0,22	0	8170
515	Medicsight	Software	1,26	1,82	1,24	1,16	1,31	46
516	Meggitt	Aerospace	66	59,4	52,9	37,5	30,77	7546
517	Melrose	Industrial machinery	3	3,1	0,2	0,8	0,8	12502
518	Memex	Software	1,3	1	1	0,9		73
519	Mercedes-Benz	Specialty retailers	1,13	3,18	4,3	4,17	5,04	722
520	Mercedes-Benz High PerformanceEngines	Auto parts	41,6	52,8	48	48,03	59,06	454
521	Merck Serono	Pharmaceuticals	6,31	3,73	2,64	3,35	2,37	238
522	Merck Sharp & Dohme	Pharmaceuticals	1,52	8,45	12,31	73,8	90,68	1387
523	Merial	Biotechnology	102,42	98,64	78,71	90,47	93,88	5646
524	MessageLabs	Computer services	8,48	9,98	10,4	5,15	3,66	518
525	Messier-Dowty	Aerospace	24,28	32,03	29,17	39,95	29,66	1020
526	M-I Drilling Fluids	Specialty chemicals	3,11	2,77	2,04	1,58	1,21	1356
527	Michelin Tyre	Tyres	5,67	5,76	1,34	1,19	1,34	2741
528	Micro Focus International	Software	25,92	21,59	14,57	13,74	14,49	755
529	Microgen	Computer services	4,87	5,59	5,12	6,16	6,16	246
530	Micron Europe	Semiconductors	0,93	12,51	13,09	9,01	8,06	183
531	Millennium Inorganic Chemicals	Specialty chemicals	2,52	2,64	1,99	1,79	2,38	391
532	Minorplanet Systems	Electronic equipment	1,7	1,7	1,5	1	1,3	288
533	Minster Pharmaceuticals	Pharmaceuticals	6,2	4,33	1,22	0,72	0,02	10
534	Mirada	Broadcasting & entertainment	0,95	0,68	0,71	1,88	0,79	92
535	Misys	Software	103,9	99,6	72,1	88,6	104,1	6130
536	MITIE	Business support services	5,8	9,5	6,6	0	0	53631

537	Molins	Industrial machinery	1,5	1,9	1,4	2,8	2,7	792
538	Mondi	Paper	7,11	8,89	8			30100
539	Monitise	Mobile telecommunications	3,44	3,68	2,21			99
540	Moog Controls	Industrial machinery	1,02	2,31	1,5	1,36	1,07	366
541	Morgan Crucible	Electrical components & equipment	13,9	9,8	8,7	8,2	12,5	9788
542	Mothercare	Broadline retailers	1,2	1,3	1,4	1,1		7452
543	Motorola	Telecommunications equipment	35	72,5	78,6	85,2	78	1509
544	Mouchel	Business support services	10,34	4,71	5,15	0	0	11592
545	Murex Biotech	Medical equipment	1,14	1,09	0,86	1,37	2	365
546	Myconostica	Biotechnology	1,47	0,69	0,56			24
547	N Brown	Apparel retailers	9,8	8,3	6,7	0	0	3189
548	Nanoco	Biotechnology	1,26	0,94	1,05	10,51	5,35	26
549	Napp Pharmaceutical	Pharmaceuticals	16,31	11,18	10,08	18,33	9	864
550	National Grid	Multiutilities	19	10	13	6	7	28067
551	National Semiconductor	Semiconductors	4,94	5,2	3,77	4,61	4,22	375
552	NATS	Transportation services	17	26,2	26,8	23,5	8,44	5084
553	NDS	Software	125,81	123,17	107,99	90,11	103,11	4018
554	NEC Europe	Computer hardware	14,17	10,98	9,09	8,09	7,1	365
555	Neoss	Medical supplies	1,24	0,18	0,33	0,17		108
556	NetPlay TV	Publishing	0,85	1,35		0	0,03	87
557	Network Rail	Railroads	1	1	1	2	3	36138
558	Network Technology	Computer hardware	0,8	0,3	0,25	0,32	0,22	34
559	Neuropharm	Pharmaceuticals	3,47	3	1,3			12
560	NeuTec Pharma	Biotechnology	0,94	0,74	2,68	5,14	3,29	23
561	Neverfail	Software	0,97	1,12	1,14	0,98	1,12	142
562	New Terex	Commercial vehicles & trucks	10,89	9,23	9,01	4,66	3,94	2395

563	Newmark Security	Business support services	1	0,6	0,89	0,89	0,46	126
564	Nipson Digital Printing Systems	Publishing	4,4	3,61	3,88	2,72	2,46	262
565	Nissan Motor	Automobiles	99,38	98,55	113,21	16,55		5121
566	Nokia	Telecommunications equipment	197,24	147,59	136,56	110,64	101,91	2431
567	Nokia Siemens Networks	Mobile telecommunications	10,93	5,82				671
568	Norbrook Laboratories	Pharmaceuticals	5,01	4,74	4,57	4,12	3,97	1106
569	Norcros	Building materials & fixtures	1,9	1,5	1,7	2,2	3,6	1756
570	Norgine	Pharmaceuticals	12,1	11,97	5,59	3,64	0,04	556
571	Northern Foods	Food products	5,5	8	9,5	11,1		9472
572	Northgate Information Solutions	Computer services	36,7					7855
573	Northumbrian Water	Water	2,1	1,8	1,8	2,1	2,3	3105
574	Norton Healthcare	Pharmaceuticals	10,51	4,68	5,73	8,65	11,59	564
575	Novar ED&S	Electronic equipment	4,47	4,79	4,07	4,02	4,06	902
576	Novar Systems	Electronic equipment	1,63	2,08	1,68	0,61	0,64	433
577	Novartis Pharmaceuticals	Pharmaceuticals	90,27	79,3	64,57	58,57	56,36	1667
578	Novartis Vaccines and Diagnostics	Pharmaceuticals	1,6	0,4	1,5	1,9	0,4	813
579	Novo Nordisk	Pharmaceuticals	6,34	9,25	7,85	8,57	6,97	347
580	Novozymes Biopharma	Biotechnology	2,45	1,83				113
581	NSK	Auto parts	8,06	5,67	4,47	3,76	3,52	2842
582	NTRGlobal	Software	2,01					326
583	Nucleus	Business support services	1,5	0,68	0,59	0,56	0	49
584	Nufarm	Commodity chemicals	0,82	0,76	1,05	1,16	1,86	85
585	OFCOM	Business support services	3,22	1,59	2,67	4,6		817

586	Offshore Hydrocarbon Mapping	Oil equipment & services	0,9	1,14	0,69	0,4	1,02	95
587	Olympus KeyMed	Medical equipment	4,11	0,64	1,2	1	0,48	1124
588	OMG	Software	3,12	4,09	3,7	2,34	1,61	264
589	Omnibus Systems	Software	2,1	2,4	2	1,8	1,5	107
590	Onyvax	Biotechnology	3,04	2,61	2,19	3,62	3,13	
591	OpSec Security	Business support services	1,73	1,93	1,8	1,5	1,08	262
592	Optos	Medical equipment	2,17	2,63	2,3	1,38	1,69	295
593	Oracle	Software	45,81	40,48	36	36,66	42,42	3337
594	Orchard Information Systems	Software	1,09	1,07	1,08			132
595	Organon Laboratories	Pharmaceuticals	36,78	36,41	35,28	31,49	30,55	407
596	Ortho-Clinical Diagnostics	Medical equipment	1,92	1,76	1,7	2,17	1,6	582
597	Osmetech	Medical equipment	1,82	2,67	2,75	5,6	4	64
598	Otsuka Pharmaceutical	Pharmaceuticals	1,18	2,03	2,34	3,48	3,1	275
599	Oxagen	Biotechnology	8,67	6,61	6,52	5,84	5,58	17
600	Oxford Biomedica	Pharmaceuticals	11,8	22,48	22,14	19,52	9,33	69
601	Oxford Catalysts	Specialty chemicals	2,66	1,61	0,77	0,15	0,13	84
602	Oxford Instruments	Electronic equipment	13,1	16,3	16,2	16,2	13,2	1341
603	Oxford Nanopore Technologies	Biotechnology	6,34	4,64	1,78	0,68	0,2	70
604	Oxoid	Biotechnology	5,23	5,12	5,05	4,18	4,01	372
605	Oxonica	Specialty chemicals	2,92	2,6	2,01	0,97	0,73	43
606	Pace	Telecommunications equipment	71,71	59,58	36,87	31,33	28,77	1058
607	Pactrol Controls	Electrical components & equipment	0,79	0,57	0,39	0,45	0,45	26
608	Page Aerospace	Aerospace	1,01	0,07	0,04	0,24	0,33	171
609	PAION UK	Biotechnology	4,71	5,85	7,28	4,89	3,47	12
610	Pall Europe	Industrial machinery	5,59	4,37	2,7	2,07	2,08	1791
611	Panasonic Europe	Electronic	4,25	6,66	3,15	9,89	36,88	280

		equipment						
612	Panasonic Manufacturing	Consumer electronics	2,72	2,5	2,59	1,78	7,08	567
613	Parametric Technology	Software	4,5	3,48	3,22	2,49	0	194
614	Park Air Systems	Electronic equipment	0,78	1,17	1,05	0,78	1,1	135
615	Parker Hannifin	Electronic equipment	3,39	1,53	2,08			2808
616	Parseq	Software	1,04	0,72	0,49	0,31	0,42	57
617	Pearson	Publishing	35	29	20			37164
618	Pegasus Software	Software	0,89	0,89	1,21	2,23	1,88	66
619	Pelikon	Electrical components & equipment	1,05	0,75	0,34	0,48	0,42	27
620	Pendragon	Specialty retailers	1,8	1,5	1,4	0	0	10289
621	Pentagon Chemicals	Specialty chemicals	1,51	1,05	2,52	1,85	0,36	184
622	PerkinElmer	Electronic equipment	4,62	4,27	4,62	4,85	4,61	162
623	Perkins Engines	Auto parts	61,67	37,06	36,9	32,72	28,08	3245
624	Perkins Shibaura Engines	Industrial machinery	0,97	0,68	1,74	1,35	1,32	328
625	Pfizer	Pharmaceuticals	325,66	316,42	258,28	370,18	350,48	5076
626	Pfizer Consumer Healthcare	Drug retailers	3,09	3,64	3,9	4,45	4,86	86
627	PharmaKodex	Pharmaceuticals	2,06	1,94	1,26			
628	Philips Electronics	Electronic equipment	20,1	2,2	37,4	54,1	53,5	2174
629	Photo-Me	Recreational products	6,67	7,49	7,25	9,44	7,08	1485
630	Phytopharm	Biotechnology	3,23	1,59	4,49	4,88	6,86	27
631	Phyworks	Semiconductors	1,88	1,69	1,89	2,56	2,89	40
632	picoChip Designs	Computer services	7,74	6,5	5,97	2,96		112
633	Pilat Media Global	Software	2,16	3,93	5,83	4,11	2,66	209
634	Pilkington Automotive	Auto parts	1,34	1,99	1,53	1,06	1,68	988
635	Pilkington Technology	Building materials & fixtures	49,15	51,22	19,44	16,23	18,79	303

636	Pilkington United Kingdom	Building materials & fixtures	3,6	3,3	3,2	3,4	3,6	2037
637	PipeHawk	Electronic equipment	0,81	0,6	0,04	0,38	0,4	62
638	Piping Hot Networks	Telecommunications equipment	5,92	4,48	2,55	1,96	1,73	71
639	Pirelli UK Tyres	Tyres	1,04	1,2	1,29	1,32	1,37	1187
640	Pitney Bowes	Electronic office equipment	3,68	3,68	3,62	3,57	3,65	2455
641	Pittway Systems Technology	Electronic equipment	1,88	1,54	1,31	1,32	1,26	123
642	Plant Health Care	Specialty chemicals	1,21	0,82	0,48	0,19	0,18	76
643	Plant Impact	Specialty chemicals	1,55	0,95	0,72	0,12	0,17	14
644	Plastic Logic	Electrical components & equipment	27,44	11,71	6,19	3,86		181
645	Plethora Solutions	Pharmaceuticals	6,05	8,56	8,2	5,4	4,55	14
646	Plextek	Telecommunications equipment	1,94	0,97	1,67	1,54	0,56	112
647	Portrait Software	Software	2,72	3,62	3,55	3,58	3,14	124
648	Porvair	Renewable energy equipment	2,74	3	2,48	2,89	3,29	511
649	PowderMed	Pharmaceuticals	45,57	22,13	9	5,46	1,69	39
650	PPG Architectural Coatings	Specialty chemicals	1,22	1,2	0,98	0,86	0,87	1860
651	PQ Silicas	Specialty chemicals	2,13	2,21	1,31	2,55		314
652	Practiceworks	Computer services	1,09	0,92	0,86	0,98		129
653	Premier Farnell	Industrial suppliers	8,8	8	6,2	1,5	1,4	4144
654	Premier Foods	Food products	11	11,6	6	5,1	1,5	16099
655	PricewaterhouseCoopers	Business support services	9	6	2	<0.005		15200
656	Pro-Bel	Computer services	3,03	2,88	2,36	1,59	1,55	188
657	Procter & Gamble Technical Centres	Business support services	86,06	93,76	98,06	103,17	0	1566
658	Prologic	Software	1,99	1,53	1,14	0,81	1,03	78
659	ProStrakan	Pharmaceuticals	12	10,6	10,06	10,7	22,43	259

660	Prosurgics	Medical equipment	2,12					8
661	Proteome Sciences	Biotechnology	2,96	2,92	3,14	2,87	3,13	39
662	Proximagen	Biotechnology	2,82	2,32	2,6	1,74	0,33	22
663	Prysmian Cables & Systems	Electrical components & equipment	2,12	2,77	3,34	3,59	2,46	1003
664	Psion	Computer hardware	15,42	13,69	12,77	13,47	12	947
665	Psytechnics	Electrical components & equipment	0,96	1,21	1,26	1,31	1,03	33
666	Publishing Technology	Software	3,09	2,81	2,05	1,12	1,21	159
667	PuriCore	Medical equipment	2,74	2,9	2,6	2		147
668	Pursuit Dynamics	Industrial machinery	3,29	3,56	3,43	0,63	0,47	59
669	PV Crystalox Solar	Renewable energy equipment	7,26	6,04	4,2			333
670	PZ Cussons	Personal products	2,6	3,1	4,5	3,9	3,4	8596
671	QinetiQ	Defence	7,9	11,7	14,2	12,2	11,9	13604
672	Qioptiq	Electronic equipment	3,13	1,92	1,57	0,82	0,58	510
673	Quadnetics	Business support services	1,59	2,01	1,1	0,67	0,36	455
674	Qualcomm	Mobile telecommunication s	2,73	2,2	2,61	2,99	3,83	138
675	Qualcomm Cambridge	Software	1,79	2,55	1,35	1,49	2,57	56
676	Qualcomm Poole	Software	1,81	2,47	2,51	1,33	0,77	49
677	Quantel	Electronic equipment	6,31	7,97	7,85	7,66	8,13	243
678	Quative	Software	1,68	1,34	1,12			48
679	Quintiles	Business support services	38	38				1670
680	R&R Ice Cream	Food products	1,81	1,88	2,84			1865
681	Racal Acoustics Global	Telecommunicatio ns equipment	2,01	1,99	1,5	1,83		182
682	Randox Laboratories	Biotechnology	4,99	5,54	4,84	6,09	7,65	738
683	Rapiscan Systems	Industrial	2,29	1,56	0,28	0,08		162

		machinery						
684	Raymarine	Electronic equipment	9,77	15,17	15,15	12,64	8,44	430
685	Rayner & Keeler	Medical supplies	0,79	0,6	0,58			951
686	Raytheon	Defence	0,93	0,85	0,84	0,97	1,63	1646
687	Reckitt Benckiser	Nondurable household products	122	105	88	82	63	24900
688	Reech Capital	Computer services	1,19	1,47	1,35	1,23	1,16	26
689	Reed Elsevier	Publishing	179	115	80	108	102	33300
690	Regenerative Medicine Assets	Biotechnology	9,01	9,62	8,57	5,61	4,24	78
691	Reliance GeneMedix	Biotechnology	5,18	4,44	3,42	2,33	2,21	55
692	Reliance Precision	Industrial machinery	1,15	1,17	1,39	1,08	1,13	246
693	Renesas Technology Europe	Semiconductors	15,94	19,01	18,53	0,1	0,35	394
694	ReNeuron	Biotechnology	3,13	5,17	4,37	4,3	2,4	23
695	Renewable Energy	Alternative electricity	2,2	3,29	1,05	1,11	0,49	
696	Renewable Energy Generation	Alternative electricity	2,18	2,15	1,56	4,16		19
697	Renishaw	Electronic equipment	30,25	27,31	23,43	21,3	17,14	2154
698	Renovo	Biotechnology	18,07	18,55	20,45	11,32	7,72	171
699	Rentokil Initial	Business support services	1,7	1,7	1,8	3,5	3,7	67515
700	Research Now	Media agencies	0,86	0,39	0,04	0	0	424
701	Respironics Respiratory	Medical supplies	1,46	1,09	1,32	1,29	1,92	50
702	Revolymer	Specialty chemicals	1,33	0,93	0,5	0,18		33
703	Rexam	Containers & packaging	23	24	15	15	21	22900
704	Ricardo	Business support services	11,4	9,1	7,9	4,5	3,9	1630
705	Ricoh Europe	Electronic office equipment	20,8	21,3				14301
706	Rio Tinto	General mining	119,51	190,11	42,73	9,29	12,39	95608

707	RM	Software	14,63	13,18	14,89	14,92	16,69	2711
708	Robert Bosch Investment	Building materials & fixtures	7,5	6,9	4,6	3,3	3	1614
709	Robinson Brothers	Specialty chemicals	0,81	0,78	0,78	0,81	0,83	263
710	Roche Products	Pharmaceuticals	208,44	181,01	163	141,9	96,73	1476
711	Rockwell Collins	Aerospace	1,36	0,65	0,11	0,75	0,68	436
712	Rofin-Sinar	Electronic equipment	1,48	1,24	0,84	1,23	1	91
713	Rolls-Royce	Aerospace	471	490	454	411	352	38500
714	Rosemont	Pharmaceuticals	3,08	2,58	2,33	1,54	0,88	208
715	Rosemount Aerospace	Aerospace	1,05	0,14	0,12	0,31	0,06	60
716	Rotork	Industrial machinery	3,56	3,55	3,38	2,76	2,67	1764
717	Royal Dutch Shell	Integrated oil & gas	696,64	783,95	743,7	548,02	364,11	101000
718	RWE Npower	Conventional electricity	9	9	8	4	3	2573
719	SABIC UK Petrochemicals	Commodity chemicals	3,35	2,99	2,91	2,92	3,71	899
720	SABMiller	Brewers	2,48	4,34	5,57	3,72	4,95	70131
721	Sage	Software	174,6	139,7	111,4	94,9	81,6	14352
722	Sagentia	Business support services	5,21	6,23	6,09	5,19	5,06	194
723	SAI Automotive Fradley	Auto parts	1,07	1,21	6,61			357
724	Salamander Enterprises	Software	1,51					79
725	Samsung Electronics	Electronic equipment	33,38	24,04	21,76	29,74	23,59	878
726	Sanofi Pasteur MSD	Drug retailers	1,21	2,41	2,03	1,7	1,93	168
727	Sarantel	Telecommunications equipment	1,05	1,06	0,65	0,7	0,26	48
728	Satamatics Global	Computer services	1,09	1,09	1,1			49
729	Scaid Investments	Home construction	1,03	1,04	0,82	0,69	0,68	788
730	Scancell	Biotechnology	1,09	0,5	0,22			6
731	Scapa	Specialty chemicals	4,1	4	3,1	3,4	3,4	1260
732	Schering-Plough	Pharmaceuticals	3,73	4,26	4,5	4,34	9,52	774

733	Schneider Electric	Electrical components & equipment	0,96	1,34	2,67	1,93	1,29	1787
734	SciSys	Computer services	1,74	1,29	0,45	6,99	8,8	444
735	Scott Health & Safety	Business support services	1,22	2,39	2,1	0,87	0,83	231
736	Scottish and Southern Energy	Conventional electricity	4,2	4,4	3,7	6,3	1,4	19308
737	Scottish Power	Conventional electricity	1,5	1,6	1	0,3	0,2	9024
738	SCOTTY	Telecommunications equipment	0,9	0,68	0,8	0,55	0,69	36
739	SDL	Software	11,04	8,04	5,37	4,72	3,88	1950
740	SELEX Communications	Telecommunications equipment	4,22	3,91	3,31	3,57		821
741	SELEX Sensors and Airborne Systems (now SELEX Galileo)	Electronic equipment	112,74	139,7	122,48	120	88	4129
742	Senetek	Pharmaceuticals	0,79	0,71	0,72	0,81	0,89	9
743	Senior	Aerospace	8,3	7,4	7,3	7,7	7,7	4873
744	Sepura	Telecommunications equipment	13,51	15,31	13,82	12,36	7,6	301
745	Serck Controls	Computer services	0,92	0,79	0,56	0,35	0,31	144
746	Serco	Business support services	64,4	63,6	75,5	77,3	45,3	57710
747	Serentis	Pharmaceuticals	3,76	5,41	1,49	0,22		
748	Servier R&D	Biotechnology	25,1	19,84	16,62	10,82	7,81	98
749	Seton House	Aerospace	14,6	24	16,8	26,7	19,3	3514
750	Severn Trent	Water	21,8	18,9	15,5	4,2	3,9	8788
751	Sharp Electronics	Electronic equipment	6,89	5,02	4,58	6,73	7,07	674
752	Shepherd Building	Heavy construction	0,9	0,8	0,9	1,1	1,1	3717
753	Shire	Pharmaceuticals	346,71	298,35	301,57	187,13	177,81	3875
754	SHL	Business training & employment agencies	4	4,63	3,9	3	2,9	745
755	SHS International	Food products	2,85	3,62	0,25	0,71		331
756	Siemens	Electrical	3,56	2,89	3,33	2,45	1,66	6674

		components & equipment						
757	Siemens Industrial Turbomachinery	Industrial machinery	16,63	15,52	13,71	19,87	18,54	1551
758	Siemens IT Solutions and Services	Business support services	1,38	0	0	0	0	3645
759	Siemens Magnet Technology	Electrical components & equipment	6,18	6,57	6,99	6,04	7,24	568
760	Siemens Product Lifecycle Management (now Siemens Industry Software)	Software	8,48	8,95	8,55	8,74	8,3	383
761	Siemens Product Lifecycle Management Software III	Software	1,2	1,09	1,06	1,04	0,99	29
762	Siemens VAI Metals Technologies	Industrial machinery	2,69	1,97	0,56	0,3	0,49	605
763	Silence Therapeutics	Biotechnology	5,07	6,71	4,84	3,19	1,66	43
764	Sinosoft Technology	Software	4,03	2,36	2,22	1,27	0,86	366
765	SKF	Industrial machinery	1,84	1,23	0,98	0,98	0,7	1011
766	SkyePharma	Pharmaceuticals	10,3	14,5	29,7	31,6	26	235
767	Smart Holograms	Electronic equipment	0,86	1,04	1,41	0,38	0,79	30
768	smartFOCUS	Software	1,5	1,5	1,4	1,5		125
769	Smith & Nephew	Medical equipment	95,98	94,12	87,93	74,31	67	9764
770	Smiths	Diversified industrials	89,2	72,5	125,8	216,6	160,5	21800
771	Software Radio Technology	Semiconductors	1,07	2,92	2,3	2,22	1,46	27
772	Solar Century	Renewable energy equipment	1,35	1,04	0,56	0,23	0,02	106
773	Solid State Logic	Electronic equipment	1,61	1,4	1,1	0		170
774	SolidWorks R&D	Software	1,49	1,14	1,35	0,88	0,78	66
775	Sonardyne	Oil equipment &	1,91	1,43				240

		services						
776	Sondex Wireline	Oil equipment & services	1,12	2,74	3,19	2,52	1,95	187
777	Sony	Consumer electronics	17,98	6,46	13,78	12,42	15,71	2013
778	Sony Computer Entertainment Europe	Toys	84,79	82,45	100,29	72,94	59,04	1323
779	Sopheon	Software	2,3	1,97	1,49	1,22	1,01	99
780	Sophos	Software	33,8	24,88	20,12	13,64	10,14	1339
781	Sosei R&D	Biotechnology	6,12	14,2	13,24	10,35	9	15
782	SPD Development	Biotechnology	8,36	9,36				125
783	Speakerbus	Telecommunicatio ns equipment	0,99	1,06	0,9	0,6	0,82	134
784	Spectris	Electrical components & equipment	58,2	57	45,2	44,7	44,9	5764
785	Sphere Medical	Medical equipment	3,84	2,62	1,95	1,5	0,98	49
786	SPI Lasers	Electronic equipment	3,04	3,05	2,4	2,96	2,92	159
787	SpinVox	Mobile telecommunication s	12,05	10,17	5,28	0,61	0,04	296
788	Spirax-Sarco Engineering	Industrial machinery	8,02	6,53	6,27	5,81	5,37	4377
789	Spirent Communications	Telecommunicatio ns equipment	47,5	45,3	46,3	58	62,8	1449
790	SSL International	Personal products	13,2	11,8	10,2	8,8	8,2	9030
791	Stannah Lifts	Industrial machinery	2,46	2,14	1,44	1,48	1,09	1665
792	StatPro	Software	3,83	4,31	3,83	2,63	1,97	243
793	SThree	Business training & employment agencies	1,93	3,34	7,37	2,89	0,01	1841
794	STMicroelectronics R&D	Semiconductors	28,2	30,43	31,69	29,51	29,37	350
795	Strategic Thought	Computer services	1,45	1,3	1,27	0,72	0,58	68
796	Sumitomo Electric Wiring Systems	Auto parts	2,35	2,6	2,16	1,45	2,09	11538
797	Summit	Pharmaceuticals	2,3	5,75	8,41	2,94	1,03	73

798	Sun Chemical	Specialty chemicals	8,6	8,59	9,74	8,34	8,74	1544
799	SunGard Public Sector	Electronic equipment	1,81	1,14	1,99	2,37	1,76	932
800	SunGard Sherwood Systems	Software	1,27	1,6	1,1	1,8	1,77	129
801	SunGard Systems	Computer services	13,49	9,29	10,31	10,69	12,42	496
802	Sunrise Medical	Medical equipment	0,81	1,14	1,34	1,55	1,78	251
803	Sunshine Holdings 3	Broadcasting & entertainment	1,88	2,93	2,86	1,13		292
804	Surface Technology Systems	Semiconductors	0,8	3,11	3,02	2,77	2,88	120
805	Surface Transforms	Auto parts	0,84	0,62	0,56	0,58	0,47	23
806	Surgical Innovations	Medical equipment	1,07	0,73	0,45	0,25	0,25	63
807	Surrey Satellite Technology	Telecommunications equipment	1,2	1,22	4,08	3,98	8,4	299
808	Symantec	Software	11,22	12,52	12,93	9,96	0	1022
809	Symbian Software	Software	118,91	94,68	72,67	55,26	46,2	1050
810	Synairgen	Pharmaceuticals	2,11	2	1,53	1,07	0,56	23
811	Synchronica	Software	1,5	1,42	0,97	1,18	0,42	74
812	Syngenta	Specialty chemicals	96	97	100	103	72	1403
813	Syngenta Seeds	Farming & fishing	2,74	2,04	2,18	1,75	1,95	92
814	Syntaxin	Pharmaceuticals	3,53	1,53	0			47
815	Syntopix	Pharmaceuticals	0,86	1	1,4	0,49	0,17	17
816	System C Healthcare	Computer services	3,05	1,7	1,34	1,16	1,19	206
817	Tandberg Products	Telecommunications equipment	4,25	1,58	1,39	0,64	0,42	81
818	Target	Software	1,39	1,1	1,49	1,62	0,75	302
819	Tata Steel Europe	Iron & steel	77	86	78	76	66	36100
820	TATA TEA	Soft drinks	0,8	0,6	1	0,9	1,3	988
821	Tate & Lyle	Food products	26	28	32	22	21	5616
822	TDG	Transportation services	3,4	3,3	4,1	3,3	3,2	7287
823	TDK-Lambda	Electronic equipment	1,34	1,66	1,29	1,57	1,56	256
824	Technolog	Electronic equipment	1,31	1,22	1,23	0,97	0,82	196
825	Telefonica O2	Mobile	48	60	58,91	85,2	4,86	11385

		telecommunications						
826	Telephonetics	Software	1,09	0,83	0,72	0,54	0,44	111
827	Telesoft Technologies	Telecommunications equipment	4,23	3,88	2,95	2,88	2,65	116
828	TeleWare	Software	1,02	0,94	1,62	1	1,12	100
829	Telex Communications	Electronic equipment	2,42	2,35	2,07	1,98	1,5	131
830	Telit Communications	Telecommunications equipment	8,61	7,8	7,7	7,24	3,48	362
831	Temenos	Computer services	6,3	7,88	7,04	6,67	4,51	210
832	Ten Lifestyle Management	Business support services	1,18	0,96	0,39	0,32		183
833	Tennants	Commodity chemicals	1,05	1,26	1,48	1,94	1,95	843
834	Teradyne Diagnostic Solutions	Software	2,54	3,54	3,36	2,79	2,8	183
835	Tesco	Food retailers & wholesalers	111	192	128	129	115	472094
836	Thales Avionics	Electronic equipment	13,38	9,33	14,38	7,49	2	336
837	Thales e-Security	Computer services	5,3	8,66	7,75	5,68	0,43	185
838	Thales Missile Electronics	Defence	1,33	1	0,71	0,6	0,36	217
839	Thales Naval	Defence	0,79	1,07	0,55	0,95	1,1	61
840	Thales Optronics	Defence	3,11	1,26	2,7	2,24	1,51	584
841	Thales Training and Simulation	Aerospace	1,75	0,63	2,85	4,19	3,9	913
842	Thales UK	Defence	8,64	10,36	7,45	5,92	4,18	2143
843	Thales Underwater Systems	Electronic equipment	2	2,37	2,2	3,85	3,69	698
844	Thiakis	Pharmaceuticals	4,19	2,97	0,38	<0.005		5
845	Thomson Reuters	Publishing	106,51	190	176	121	128	33708
846	Thorn Security	Business support services	3,61	3,8	3,48	3,17	3,23	215
847	Thornton & Ross	Pharmaceuticals	0,79	1,01	0,88	1,79	0,46	374
848	TIBCO Software	Software	2,89	2,8	2,93	0,95	0	220
849	Tideway Systems	Software	1,51	1,7	2,02	1,61	1,15	94
850	Tikit	Computer services	1,15	0,74	0,47	0,25	0,28	211

851	Time Warner	Broadcasting & entertainment	30,66	0	0	0	0	3513
852	Tioxide Europe	Specialty chemicals	1,04	1,1	0,73	0,37	0,98	565
853	Tissue Science Laboratories	Medical equipment	1,54	2,02	2,27	1,3	1,41	61
854	Titan Europe	Commercial vehicles & trucks	3,6	4,03	2,91	0,44	0,18	2336
855	T-Mobile	Mobile telecommunications	10,3	19,92	14,36	71,67		5795
856	Tokheim	Industrial machinery	4,4	2,8	1,61	1,53	1,11	380
857	Tomkins	Diversified industrials	48,67	57,4	51,9	52,8	46,7	26797
858	TopoTarget	Biotechnology	2,47	2,98	2,45	1,61	2,08	8
859	Torotrak	Auto parts	5,23	5,27	4,57	4,45	5,21	60
860	Toshiba Research Europe	Electronic equipment	7,76	7,26	7,23	7,36	6,73	80
861	Total Upstream	Exploration & production	6,14	6,63	6,16	5,96		609
862	Toyota	Specialty retailers	3,85	4,26	3,44	3,55	0	336
863	Trafficmaster	Telecommunications equipment	3,7	4,35	3,82	3,08	1,52	524
864	Trelleborg Industrial Products	Auto parts	1,13	1,78	1,77	2,15	2,15	238
865	Tribal	Business support services	1,79	1,11	1,51	2,49	1,05	2283
866	TRL Technology	Defence	5,68	4,59	5,4	3,49	1,47	352
867	TRW	Auto parts	11,54	14,55	17,05	21,5	26,6	1685
868	TT electronics	Electrical components & equipment	6,9	10,3	9,5	8,6	8,7	6403
869	TTP	Computer services	1,5	1,61	1,93	2,21	3,36	292
870	TTP Communications	Telecommunications equipment	9,07	28,31	26,59	34,79	29,5	128
871	Tulip	Computer services	1,02	1,14	0,81	1,05	0,68	157
872	Tunstall Healthcare	Medical equipment	3,67	3,42	3,35	3,61	0,34	1135
873	Turbo Power Systems	Electronic	5,25	4,56	1,18	1,81	1,88	141

		equipment						
874	Turner Powertrain Systems	Commercial vehicles & trucks	1,09	0,99	0,54	0,64	0,46	362
875	Ubichem	Commodity chemicals	1,28	0,72	0	0,48	0,44	117
876	Ubiquisys	Telecommunicatio ns equipment	4,93	6,09	6,57	3,95	0,15	54
877	UK Mail	Delivery services	0,9	0,9	0,3	0	0	2672
878	Ultra Electronics	Defence	34,51	33,1	29,25	20,61	15,8	3961
879	Ultronics	Electrical components & equipment	1,2	1,2	1,1	1,38	1,21	25
880	Umbro International	Clothing & accessories	4,48	4,48	5,53	3,94	3,59	231
881	UMECO	Aerospace	2	2	1,6			1666
882	Unicom	Software	5,25	5,13	4,87	5,17	5,04	239
883	Unilever	Food products	791,65	823,63	771,21	804,98	846,74	16800 0
884	Unipath	Medical supplies	5,59	5,65	4,01	5,87	4,02	316
885	Uniq	Food products	1,4	1,8		0		6195
886	United Biscuits	Food products	5,3	5	5,7	10,8	10,7	8477
887	United Utilities	Water	0,8	0,9	1,7	2,4	1,9	9365
888	Universe	Business support services	1,26	1,54	1,46	0,93	1,48	206
889	Urenco	Conventional electricity	10,75	6,4	5,95	11,11	13,79	3015
890	Vantia	Pharmaceuticals	7,02	3,72				27
891	Vascutek	Medical equipment	5,42	3,97	3,27			489
892	Vectura	Pharmaceuticals	36,4	32,3	29,66	16,99	8,03	267
893	Vedanta Resources	General mining	0,87	0,5	0,31	0,31	0,19	29597
894	Velocity	Software	2,29	1,56	2,85	2,47	1,95	358
895	Velti	Software	12,88	6,29	3,13	1,28	0,71	459
896	Vernalis	Biotechnology	11,04	13,95	18,22	20,61	26,49	89
897	Vero Software	Software	3,14	3,06	2,94	2,07	1,45	157
898	Verona Pharma	Biotechnology	0,95	0,88	0,76	0,14		16
899	Vertex Pharmaceuticals	Pharmaceuticals	12,13	10,94	9,53	8,68	8,42	98
900	Vetco Gray	Oil equipment & services	3,22	4,32	3,28	2,15	0	1212

901	Vetco Gray Controls	Oil equipment & services	1,14	1,68	1,22	1,64	0,68	460
902	ViaLogy	Software	0,92	1,25	0,35	0	0	30
903	Vicorp	Software	1,14	1,04	1,09	1,41	1,13	33
904	Victrex	Specialty chemicals	3,98	3,62	3,57	2,48	4,17	509
905	Videojet Technologies	Electronic equipment	3,94	4,19	3,56	3,87	3,22	105
906	Virgin Mobile Telecoms	Mobile telecommunication s	0,96	1,64	2,36	4,15	0	800
907	Vislink	Telecommunicatio ns equipment	9,52	9,1	7,6	6,21	6	475
908	Vitec	Industrial machinery	13,1	12,5	10,4	9,9	7,8	1957
909	VocaLink	Financial administration	13,8	29,86	29,75	32	29,25	762
910	Vodafone	Mobile telecommunication s	303	280	234	222	206	84990
911	Volantis Systems	Software	1,37	2,06	2,65	2,32	1,46	105
912	Volex	Electrical components & equipment	1,66	1,66	1,11	1,78	1,79	6794
913	Vyke Communications	Telecommunicatio ns equipment	1,75	2,25	0,75	0,66	0,38	54
914	W L Shareholding	Electrical components & equipment	2,96	2,51	2,07	1,54	1,52	605
915	Wagon	Auto parts	7,2	14,2	8,8	9,5	11,1	5702
916	Waterford Wedgwood	Durable household products	2,4	3,7	3,8	4,6	3,5	6929
917	Weetabix	Food products	1,22	0,99	0,62	1,04	1,13	2029
918	Weir	Industrial machinery	9,7	9,8	8,9	6,1	5,25	8805
919	Wellstream	Oil equipment & services	3,57	4,01	3,19	2,32	2,76	1118
920	Westland Helicopters	Aerospace	19,03	22,85	12,57	11,1	12,67	3177
921	Weston Aerospace	Aerospace	3,77	2,93	3,45			286

922	White Young Green	Business support services	5,09	5,19	0	0	0	3185
923	Win	Mobile telecommunications	0,87	0,72	0,55	0,65		113
924	Winthrop Pharmaceuticals	Pharmaceuticals	1,52	1,35	1,58		1,28	35
925	Wittington Investments	Food products	23	21	16	12	11	96980
926	Wolfson Microelectronics	Semiconductors	23,41	24,72	25,3	20,61	13,29	381
927	Wood Mackenzie	Business support services	3,7	2,18	2,33	0,41		621
928	Workplace Systems International	Software	2,14	2,86	2,5	2,44	2,41	114
929	Xaar	Computer hardware	3,85	4,28	6,87	7,43	5,83	318
930	Xchanging	Business support services	16,68	9,58	4,38	2,05	2,44	8601
931	Xerox	Electronic office equipment	10	11	11	15	31	1700
932	Xstrata	General mining	1,24	3,72	3,72	2,48	0,37	37845
933	Yazaki Europe	Auto parts	6,84	9,17				830
934	YouGov	Media agencies	1,03	0,58	0,13	0	0	431
935	Yule Catto	Specialty chemicals	9,58	10,17	9,08	10,5	10,52	2045
936	Zarlink Semiconductor	Semiconductors	2,82	2,08	1,98	9,04	16,11	131
937	Zenergy Power	Electrical components & equipment	3,59	3,95	3,08	1,67		93
938	Zeus Technology	Software	0,79	0,66	0,64	0,63	0,49	63
939	ZincOx Resources	General mining	3,17	3,71	3,64	4,07	1,91	162
940	1E	Software	2,29	0,79	0,77	0,76	0,44	120
941	2ergo	Mobile telecommunications	1,51	0,87	0,31	0,11	0,46	94

APPENDIX C –Tables and figures

Descriptive Statistics

	Mean	Std. Deviation
Human Capital	3.2235	1.0304
Country Risk	3.4119	0.9443
National Innovation System	3.2633	0.9887
Cost	3.5330	1.2451
Cultural Difference	3.1111	1.0127
Experience	3.6296	0.9081
Speed of the project	3.82	1.114
Quality of the project	3.92	.946
Reputation of the firm	3.71	1.193
Capability of the firm	3.40	1.285
Classification of the project	2.28	.595
Routineness of the project	2.77	1.577
Interactivity of the project	3.06	1.418
Innovativeness of the project	3.04	1.381
Number of employees	22328.43	32914.196
Number of R&D employees	2529.81	4691.266
The age of the company	64.78	51.487
Log of the number of employees	3.8477	0.7694
Log of the number of R&D employees	2.8036	0.7703
Log of the age of the company	1.6709	0.3619
The degree of innovativeness of the offshored R&D activities	3.0030	1.1309
The degree of routineness of the offshored R&D activities	3.2460	1.2167

Multiple Comparisons – Post Hoc Tests

	(I) Location	(J) Location	Mean Dif. (I-J)	Std.Error
Tukey HSD	EU15	Japan, Korea, Singapore & Taiwan	0.157	0.177
		India & China	1.794***	0.141
		Middle East, South America & Russia	1.716***	0.170
		USA, Canada & Australia	0.245	0.144
	Japan, Korea, Singapore & Taiwan	EU15	-0.157	0.177
		India & China	1.636***	0.175
		Middle East, South America & Russia	1.558***	0.199
		USA, Canada & Australia	0.088	0.177
	India & China	EU15	-1.794***	0.141
		Japan, Korea, Singapore & Taiwan	-1.636***	0.175
		Middle East, South America & Russia	-0.077	0.168
		USA, Canada & Australia	-1.548***	0.141
	Middle East, South America & Russia	EU15	-1.716***	0.170
		Japan, Korea, Singapore & Taiwan	-1.558***	0.199
		India & China	0.077	0.168
		USA, Canada & Australia	-1.470***	0.170
	USA, Canada & Australia	EU15	-0.245	0.144
		Japan, Korea, Singapore & Taiwan	-0.088	0.177
		India & China	1.548***	0.141
		Middle East, South America & Russia	1.470***	0.170
Games-Howel	EU15	Japan, Korea, Singapore & Taiwan	0.157	0.184
		India & China	1.794***	0.132
		Middle East, South America & Russia	1.716***	0.158
		USA, Canada & Australia	0.245	0.137
	Japan, Korea, Singapore & Taiwan	EU15	-0.157	0.184
		India & China	1.636***	0.192
		Middle East, South America & Russia	1.558***	0.211
		USA, Canada & Australia	0.088	0.195
	India & China	EU15	-1.794***	0.132
		Japan, Korea, Singapore & Taiwan	-1.636***	0.192

		Middle East, South America & Russia	-0.077	0.168
		USA, Canada & Australia	-1.548***	0.148
	Middle East, South America & Russia	EU15	-1.716***	0.158
		Japan, Korea, Singapore & Taiwan	-1.558***	0.211
		India & China	0.077	0.168
		USA, Canada & Australia	-1.470***	0.172
	USA, Canada & Australia	EU15	-0.245	0.137
		Japan, Korea, Singapore & Taiwan	-0.088	0.195
		India & China	1.548***	0.148
		Middle East, South America & Russia	1.470***	0.172

Results of Helmert Contrast (K Matrix)

Type of offshoring - Repeated Contrast		Dependent Variable The degree of innovativeness of the offshored R&D activities
Captive Offshoring vs. Offshore Outsourcing	Contrast Estimate	1.256
	Hypothesized Value	0
	Difference (Estimate - Hypothesized)	1.256
	Std. Error	0.109
	Sig.	0.000

Multiple Comparisons – Post Hoc Tests

	(I) Location	**(J) Location**	**Mean Dif. (I-J)**	**Std.Error**
Tukey HSD	EU15	Japan, Korea, Singapore & Taiwan	-0.383	0.214
		India & China	-1.661***	0.171
		Middle East, South America & Russia	-1.615***	0.206
		USA, Canada & Australia	-0.127	0.174
	Japan, Korea, Singapore & Taiwan	EU15	0.383	0.214
		India & China	-1.278***	0.212
		Middle East, South America & Russia	-1.232***	0.241
		USA, Canada & Australia	0.256	0.214

	India & China	EU15	1.661***	0.171
		Japan, Korea, Singapore & Taiwan	1.278***	0.212
		Middle East, South America & Russia	0.045	0.203
		USA, Canada & Australia	1.534***	0.171
	Middle East, South America & Russia	EU15	1.615***	0.206
		Japan, Korea, Singapore & Taiwan	1.232***	0.241
		India & China	-0.045	0.203
		USA, Canada & Australia	1.488***	0.206
	USA, Canada & Australia	EU15	0.127	0.174
		Japan, Korea, Singapore & Taiwan	-0.256	0.214
		India & China	-1.534***	0.171
		Middle East, South America & Russia	-1.488***	0.206
Games-Howel	EU15	Japan, Korea, Singapore & Taiwan	-0.383	0.251
		India & China	-1.661***	0.153
		Middle East, South America & Russia	-1.615***	0.184
		USA, Canada & Australia	-0.127	0.184
	Japan, Korea, Singapore & Taiwan	EU15	0.383	0.251
		India & China	-1.278***	0.241
		Middle East, South America & Russia	-1.232***	0.262
		USA, Canada & Australia	0.256	0.262
	India & China	EU15	1.661***	0.153
		Japan, Korea, Singapore & Taiwan	1.278***	0.241
		Middle East, South America & Russia	0.045	0.170
		USA, Canada & Australia	1.534***	0.170
	Middle East, South America & Russia	EU15	1.615***	0.184
		Japan, Korea, Singapore & Taiwan	1.232***	0.262
		India & China	-0.045	0.170
		USA, Canada & Australia	1.488***	0.199
	USA, Canada & Australia	EU15	0.127	0.184
		Japan, Korea, Singapore & Taiwan	-0.256	0.262
		India & China	-1.534***	0.170
		Middle East, South America & Russia	-1.488***	0.199

Results of Helmert Contrast (K Matrix)

Type of offshoring - Repeated Contrast		Dependent Variable: The degree of routineness of the offshored R&D activities
Captive Offshoring vs. Offshore Outsourcing	Contrast Estimate	-1.161
	Hypothesized Value	0
	Difference (Estimate - Hypothesized)	-1.161
	Std. Error	.144
	Sig.	.000

Summary of the models analyzed pseudo R^2

Model	Pseudo R^2	Log likelihood	Chi-square
1A	0.141	- 338.161	110.560
1B	0.521	- 188.506	409.670
1C	0.541	- 180.569	425.562
2B	0.251	- 204.878	197.742
2C	0.3	- 275.231	236.419
3B	0.484	- 176.868	380.632
3C	0.517	- 190.155	406.572
4A	0.141	- 338.161	110.560
4B	0.541	- 180.569	425.562
4C	0.584	- 164.065	458.750
4D	0.757	- 95.623	595.634