Foreign-owned R&D facilities in China, England, Germany, and Sweden

An analysis of regional entry and integration behavior

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General introduction

The internationalization of corporate research and development (R&D) is an increasing trend with implications for both R&D managers and policy makers. In this research, 62 foreign-owned R&D facilities from information and communication technology (ICT) industries as well as life sciences industries are examined at five locations throughout the world to find global and regional trends in the internationalization of R&D. More specifically, models are identified based on how foreign R&D facilities select locations, enter the selected locations, and integrate with the environment at these locations. Due to the fact that these phenomena are relatively new, and since the population of foreign-owned R&D facilities even at leading locations world-wide is limited, little has been written about them to date. High levels of heterogeneity among foreign-owned R&D facilities make it difficult to generate statistically relevant sample sizes.

The increasing speed of global technological change, the increasing complexity of knowledge, and shortening product lifecycles are leading to intensified competition between technology companies on the one hand, but also between technology regions on the other hand. Increasing understanding of the entry and integration processes of foreign-owned R&D facilities as the internationalization of R&D progresses can thus be of value to both R&D managers and policy makers. What is the character of different locations hosting foreign-owned R&D? Which factors drive location decisions? Which entry modes are chosen to set up a foreign R&D presence and what kind of behavior do companies display when entering a foreign region with R&D? Which external partners do the foreign-owned facilities collaborate with and which networks are used to gain access to and integrate with local knowledge resources? In the greater context of economic theory, especially in the field of neo-Schumpeterian economics, it is becoming more and more difficult to clearly distinguish between economic- and business-driven approaches to explaining innovation. Modern innovation research following a micro-to-macro approach (Eliasson, 1991) places the innovating actor at the center of its attention and proceeds via endogenous aggregation to determine growth effects at the economy-wide level. Foreign direct R&D investment is an interesting phenomenon in this context. Driven by company decisions to source knowledge resources internationally, foreign R&D investments can have a considerable impact on strengthening the innovation environment of a given economic area. However, companies have been highly selective concerning where they invest internationally with R&D.

Understanding the internationalization of R&D requires a holistic conceptualization of innovation as a phenomenon driven by numerous factors coming from diverse fields such as business, economics, sociology, and history. The institutional environment may play a central role in this context. This research will show how the 'diversity of modern capitalism' (Amable, 2003; Hall and Soskice, 2001), especially relating to institutions in different regional environments, impacts the entry and integration behavior of foreign-owned R&D facilities that set up operations abroad. The internationalization of R&D is an especially interesting field of research as it is inextricably connected with both business- and economics-driven dimensions of innovation. In fact, the phenomenon of a foreign-owned R&D facility implies that a company innovation system must in some way integrate with a regional innovation system. The once supposedly distinct business and economic aspects of R&D internationalization thus become two sides of one and the same coin. Originally coming from a business education background, I found this 'micro meets macro' approach to be especially interesting taking into account regional governments' ongoing efforts to make their regions more attractive to international R&D investment, while global companies at the same time actively seek to gain access to leading knowledge resources, which in turn are asymmetrically and globally dispersed throughout leading regions around the world.

Which factors determine companies' R&D location decisions, entry behavior, and integration behavior in such complex global environments? How does entry and integration behavior vary between different regions of the world? The existing theory does not provide any answers. The starting point to gain a structured insight into this unexplored field of research was to identify some leading locations for foreign-owned R&D around the world, and to generate some sort of generic conceptual model enabling a comparison of these innovation environments. The second step was to examine the characteristics of the foreign-owned R&D going on at these locations. Next, in order to gain insight into the entry and integration behavior as indicated by the title of this research, foreign-owned facilities in each of the regions were examined in terms of (1) why they came to conduct R&D in the region, (2) how they entered the region to set up R&D activities, and (3) how they used different kinds of human resources and networks to become integral players in the local R&D environment. The result of the research is a collection of detailed case studies based on quantitative data comparing how the phenomenon of R&D internationalization manifests itself in each of the five presented regional environments.

This research can be used as a work of reference to gain insight into which factors can play a role in determining location, entry, and integration behavior in the internationalization of R&D. Once again it must be added however, that due to the relatively small size of the international population of foreign-owned R&D facilities and the high levels of its heterogeneity, the insight gained in this study cannot claim to be globally representative. The research takes an explorative and deductive approach to enable a basic understanding of the highly heterogeneous field. Face-to-face interviews using structured and semi-structured questionnaires lead to the identification of five generic types of regions for foreign R&D. Each of these region-types is specific in terms of the entry- and integration-behavior of foreign-owned R&D facilities located there. In addition, the empirical study formulates several generic dimensions by which different types of foreign-owned R&D facilities can be characterized. Understanding different region- and facility-types as they relate to location selection, entry, and integration may enable R&D managers to improve the competitiveness of their global R&D efforts, while enabling regional policy makers to improve the competitiveness of their regions as recipients of foreign direct investment (FDI) in technology-related sectors.

Section 1 gives a theoretical introduction to the subject matter, covering the concepts of innovation and technological change, R&D and its internationalization, industrial clusters, regional innovation systems, entry modes for FDI, and the compatibility between corporate and regional innovation systems. It then introduces the empirical study.

Section 2 describes the five generic regional typologies as the basis of the empirical study. It covers the government-centric, urban-centric, university-centric, and key-company-centric, and triple-helix-centric models, and describes them in the context of the five R&D locations of Beijing, London, Cambridge (UK), Stockholm, and Munich.

Section 3 presents the variables used in the study to gain an understanding of how foreign-owned R&D facilities and their behavior vary between different locations world-wide. The section also presents the MMB model as the conceptual model for the description of different foreign-owned R&D facility types in this study.

Section 4 presents the intra-regional analysis of the five studied locations using basic descriptive statistics and qualitative analysis. It consists of three parts, covering (1) basic demographics and characteristics of foreign-owned R&D, (2) entry behavior of foreign-owned facilities, and (3) integration behavior of foreign-owned facilities at each of the five locations. Generic facility-typologies are identified in the process.

Section 5 identifies global trends in the character of foreign-owned R&D facilities, their location decision behavior, as well as entry and integration behavior based on a sample of all 62 facilities covered in this study and by then seeking significant Pearson correlations between key variables of each of the areas of research. The findings indicate that certain trends in internationalization behavior are global, whereas others are regional.

Section 6 introduces two-step cluster analyses to examine validity and overlaps between the identified regional and global typologies. It confirms the great heterogeneity of foreign-owned R&D facilities world-wide, while at the same time delivering wide-ranging support for the models and typologies generated in the earlier sections of the work.

A general conclusion summarizes the findings of the research and gives perspectives for future research. The general conclusion is followed by references, the list of figures and tables, key to abbreviations, and a short statistical appendix.

Section 1: theoretical introduction

1.1 Innovation and technological change

Innovation is a key driver of technological change and the economic progress that occurs as technologies move through the lifecycle phases of birth, growth, maturity, and decline (OECD, 1996). Innovation is enabled by the global creation and diffusion of knowledge, and is in turn driven by the increasingly knowledge-driven character of our global economy (Bullinger, 1994). In companies, innovation activities involve efforts to create and improve products and processes, technological and human skill-sets, as well as different innovation management systems (OECD, 1996). In regions, innovation activities involve private and public efforts to create an environment for knowledge exchange in the 'regional innovation system' (RIS), which is referred to in detail further below, to enable regional innovators to leverage the full knowledge potential of the region, and attract further regional investment in knowledge-intensive sectors.

From the corporate strategy perspective, innovation activities aim to achieve competitive advantage based on cost or differentiation that would enable a company to benefit from first mover advantages and/or temporary (legal) monopolistic market positions (Schumpeter, 1942). Innovation activities thus either aim to defend a current advantage or to seek new advantage. Innovation activities can be of a reactive or a proactive nature (OECD, 1996). Enabling innovation-based strategic advantage necessitates both strategic and organizational skills. Strategic skills, referred to in greater detail below, imply the capacity to forecast technology and market developments and to use these forecasts to create profitable product/market segments. Organizational skills imply creating an organizational structure enabling the optimal absorption and internal dissipation of knowledge for the purpose of innovation, in part driven by the collaboration with external knowledge carriers.

Innovation can be incremental or radical. Incremental innovations differ from radical innovations in that they represent on-going, minor technological changes (often associated with the Japanese term 'kaizen'), whereas radical innovations represent large scale, revolutionary technological changes. Innovations (i.e. technological innovations) can have different degrees of newness. The technological change may represent something that is 'new to the product', 'new to the firm', 'new to the country', or 'new to the world'. With increasing globalization, the 'new to the country' category is becoming increasingly irrelevant.

Innovations must be distinguished from inventions. Innovations are defined as inventions with a designated commercial application. This distinction corresponds widely with the distinction between research and development, which will be explained in detail below. R&D centers with a focus on research typically produce inventions that do not find their way into marketable products for more than three years, while R&D centers with a focus on development typically produce innovations based on the knowledge created by previous inventions. These innovations typically find their way to the market within one to three years.

In the ICT and life sciences industries, innovation management is closely related to technological change and technology management. The impetus for technological change occurs in three stages, namely innovation (the generation of new ideas), development (turning ideas into marketable products), and diffusion (new products and processes spread across the market) (Stoneman, 1995). To be more precise, the term 'technology diffusion' indicates the dissipation of technology between producers, while the term 'technology adoption' describes the usage of new technology by consumers (Bullinger, 1994). Technology management covers, among other things, the management of innovation and innovation processes including the development and transfer of new technologies within a company in order to initiate or respond to technological change.

In the context of technological change, radical innovations shape big changes in the world, whereas incremental innovations fill in the process of change continuously (OECD, 1996). Technological change thus occurs through a combination of evolutionary progress and radical creative destruction: According to Kuhn (1962), technological (discontinuous) paradigm shifts usually occur after phases of continued cumulative progress within a certain paradigm. 'Normal science' is a cumulative learning process, paradigm shifts are a 'scientific revolution', and are of a destructive nature (Vanini, 1999). Technological change is not smooth nor linear. Schumpeter's creative destruction implies an abrupt reallocation of resources, including labor, between sectors and firms (OECD, 1996). Creative destruction occurs when major technological innovations represent an advance so significant, that no increase in scale, efficiency, or design can make older technologies competitive with the new one (Vanini, 1999).

The technology lifecycle represents a theoretical perspective on the rise and decline of technologies, driven in large by technology diffusion and adoption. It leads to a distinction between four technology maturity phases (Arthur D. Little typology): (1) pacemaker technologies (newly emerging, representing science-driven inventions), (2) key technologies (characterized by increasing application in the market and strong sales growth), (3) base technologies (characterized by mature application in the market and slow market growth), and (4) displaced technologies (old, practically obsolete technologies, their sales driven by economies of scale and cost). The technology lifecycle takes on the typical form of an s-curve (Bullinger, 1994). Technology and innovation management aims to ensure that technology-driven companies produce sufficient innovations to retain a competitive advantage with products that are in phases 2 and 3. As technologies move from inception to obsoletion, companies may be forced to move from one technology to another, with an s-curve that is in an earlier phase. Foresight and a profound understanding of technological and economic trends are required. Otherwise, the technological trajectory (Nelson and Winter, 1982) of the company may lead to an irrevocable loss of competitive advantage through technological lock-in, or a bet on the wrong technology. Thus, companies conduct a wide range of activities including technology scanning, technology roadmapping, technology assessments, scenario planning, and other tools, in order to forecast the evolution of technology lifecycles.

1.2 Innovation and R&D

The corporate function most commonly associated with activities surrounding technology and innovation management is the R&D function. In general terms, R&D is a combination of production factors aimed at creating knowledge. The three elements of R&D are basic research, applied research, and development (Gassmann, 1997). At the micro-level, within firms, R&D is seen as enhancing a firm’s capacity to absorb and make use of new knowledge of all kinds, not just technological knowledge (OECD, 1996). In basic research, knowledge is sought without considering perspectives for application. Applied research is the creation of knowledge with a defined practical goal in mind, and development is the actual transformation of scientific knowledge into new or improved products or processes (Gassmann, 1997). Applied research is divided into strategic and non-strategic categories.

Strategic research has longer term and less explicit objectives than non-strategic research (Stoneman, 1995). In Schumpeterian terms, basic research relates closely to invention, while applied research and development relate to innovation. The innovation process may encompass R&D but does not necessitate it.

R&D is considered an 'engine for growth' (Buderi, 2000). Shortening technology lifecycles and globalization imply that R&D is becoming increasingly critical for companies to be able to produce innovations with perspectives of market success. Growing R&D investments indicate that time-to-market and break even time are increasingly important indicators of a successful innovation (Kümper, 1995).

An important component of R&D is a company's ability to absorb technology developed elsewhere. Particularly early-stage R&D, from research to prototyping, is often directed at absorbing external knowledge to enhance a firm's knowledge base rather than to develop a concrete product. This can be seen in the large amount of research activities conducted without a clear connection to product divisions (Zedtwitz and Heimann, 2005). On the one hand, such research may lead to high dissipation rates, potentially forcing companies to pay great attention to retaining and protecting knowledge. On the other hand, companies may produce knowledge that they do not wish to use themselves, purposely allowing it to dissipate through various means to other firms, often even to competitors (Rogers, 2003). R&D aimed at recognizing and absorbing externally created technology while controlling the dissipation of internally generated knowledge, gives parent companies a head-start in competition (see the Cohen and Levinthal (1990) concept of 'absorptive capacity'). In this context, R&D in foreign environments is primarily about absorbing knowledge that is not available in the home country, thus justifying the increase in transaction costs (international R&D networks are complex and costly to manage) in turn for innovations that lead to superior positions on technology lifecycle curves in a firm's competitive market.

When the absorption of external knowledge is at stake, the term 'technology spill-over' comes into play (Cantwell and Piscitello, 2005). Technology spill-overs take place when the organization or individual benefiting from a specific technology differ from the organization or individual that originally generated the technology (Audretsch and Feldman, 1996). They often involve the communication of tacit knowledge and thus necessitate regional proximity

(Acs, Audretsch, and Feldman, 1992). Spill-overs can take place through different formal and informal channels: formally, (1) by recruiting personnel with specific knowledge and personal networks to related external knowledge carriers, (2) by acquiring companies with specific knowledge and customers as well as suppliers with related external knowledge, (3) by collaborating with external organizations with a specific knowledge, and (4) informally, by being present in proximity of external actors with a specific knowledge which is then picked up 'from the air' (i.e. through talks and presentations held at local technology events, verbal exchanges in canteens, or other informal exchange 'forums'). In brief, knowledge spill-over in regions enables small companies to expand their knowledge base (Audretsch and Weigand, 1999).

In economic terms, the inter-firm flow of knowledge that leads to technology spill-over can take on two forms: The negative conception of technology spill-over implies one company benefiting from another's R&D efforts without carrying the costs. Intellectual property rights and patenting systems aim to regulate this form of innovation diffusion by governing revenue streams and profits. The positive conception of technology spill-over applies when the innovating company is in possession of a protectable, dominant technological design. In this case, the spill-over of its technology throughout its industry (with or without royalty payments), will enable it to exploit first-mover, innovator, and superior technology advantages, e.g. by locking in customers (see the Utterback (1994) concept of 'dominant design'). Small and medium size firms (SME) tend to favor proximity to large technology-leading multi-national companies (MNC) to benefit from potential knowledge spill-over. For this reason, SME prefer technology clusters, whereas MNC that may have more to lose than to gain from the dissipation of knowledge in clusters, may prefer to locate at the edges or well outside of clusters with high densities of firms active in similar markets. The relevance of technology spill-overs in R&D indicates that there is a geographic dimension to research and development.

1.3 Innovation and clusters

R&D increasingly takes place within economic clusters that are attractive for the absorption of external knowledge due to large populations of technology-intensive competitors, suppliers, complementors, and lead customers (Saperstein and Rouach, 2002). Clusters provide a fertile ground for learning, experimentation, and innovation due to short distances, short information time lags, and relatively inexpensive communication. Often located in densely populated urban areas and/or near leading research institutes, universities, or large technology corporations, clusters are conductive to the exchange, and thus the absorption of knowledge, attracting industrial R&D and other forms of foreign direct investment both domestically and from abroad. Whereas the benefits cited above (despite some disadvantages such as high cost of labor and real estate) may be intuitively clear, the benefits that elude direct measurement, such as knowledge accumulation advantages and innovation, are not so clear. In search of models to describe the geography of innovation, several threads of literature have emerged, including the industrial cluster literature (see Porter, 1998), the industrial district literature (see Porter, 1998; Pyke, Beccatini and Sengenberger, 1990), the innovation networks literature (see Camagni, 1991; Grabher, 1993), the innovative milieu literature (see Aydalot and Keeble, 1998; Crevoisier and Maillat, 1991). The role of R&D cooperation for innovation processes has also been discussed in the competition policy literature (see Jorde and Teece, 1990, Katz and Ordover, 1990). Nonetheless, the criteria for optimal utilization of a cluster's knowledge potential remain largely unknown due to the often intangible character of cluster benefits and the heterogeneity of their knowledge sharing and innovation systems.

Even if it remains unknown how economic clusters are to be optimally leveraged, it is generally acknowledged that the innovation capital required to remain competitive in global markets is globally and asymmetrically dispersed (Gassmann, 1997). The turbulent and often unpredictable demands of world markets can only be met if global companies construct territorial linkages (Hirsch-Kreinsen, 1999). The global economy is characterized by a large variety of regional environments for the construction of such linkages to benefit corporate innovations (Gerybadze, 1999; Gerybadze and Reger, 1999). The internationalization of R&D aims to benefit from regional clustering on a global scale (Hirsch-Kreinsen, 1999). To understand more about the importance of clusters for technology-based competitive advantage, further theoretical considerations are given in the following paragraphs.

Clusters are geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions. They are linked by commonalties and complementarities in particular fields that compete but also cooperate (Porter, 1998). Clusters vary in terms of their age, their state of development, their complexity, and their structure. Clusters can be R&D-, production-, sales-, or service-driven. The geographic scope of a cluster can range from a single city or state to a country or even a network of countries. Cluster analysis captures linkages, complementarities, and spill-overs of technology, skills, information, marketing, and customer needs that cut across firms and industries. These links are fundamental to the direction and pace of new business formation and innovation (Porter, 1998). With leading knowledge regions emerging at different locations throughout the world (Saperstein and Rouach, 2002), a company's future R&D competitiveness increasingly lies outside the company or even outside the industry, residing instead in the locations of its R&D business units. In this environment, the health of the cluster increasingly determines the health of the company (Porter, 1998).

There are three economic principles of clustering (Gordon and McCann, 2000): (1) agglomeration economies, (2) industrial complex economies, and (3) social network economies. Agglomeration economies are sought by companies unable to exploit internal economies of scale. In search of external economies, they locate in clusters to (a) gain access to specialized labor pools, (b) achieve economies of scale in local capital infrastructures, and (c) absorb the maximum flow of local product and market knowledge. Industrial complex economies imply reduced spatial transportation- and communication transaction costs for companies that are part of a cluster. Social network economies are sought by companies with transaction costs resulting from bounded rationality and opportunism. By employing firm-transcending, trust-based, personal networks, inter-firm transactions can be internalized and coordinated more efficiently. Applied to R&D units in clusters, agglomeration economies take on the form of external sources of intellectual capital, industrial complex economies translate into reduced spatial intellectual capital transaction costs, and social network economies imply the availability of intellectual capital-based cooperative ventures.

Innovation, understood as the commercial application of an invention, plays a central role in clusters. Innovation is facilitated when different sources of knowledge, also referred to as 'sources of innovation' (Hippel, 1988), interact. The more explorative the R&D, the greater the importance of tacit (as opposed to codified) knowledge in the innovation process. This increases the importance of physical proximity and face-to-face contact in the R&D process, since the transfer of tacit knowledge between people and over distances is costly and often impossible through conventional information technology. In this context, globalization has lead to what is referred to in the literature as the renaissance of regional economies (Hirsch-Kreinsen, 1999), including regional clusters and islands of innovation (Simmie, 1998). The seemingly contradictory trends of globalization and regionalization are in fact not so contradictory. Within the context of increasing globalization, regional agglomerations of industrial activity become the magnets for FDI. Especially within the realm of R&D, clusters play an important role. Since the physical distribution of knowledge resources throughout national economies and the world itself is asymmetrically distributed, local agglomerations of knowledge have formed, attracting the lion's share of global foreign direct investment in R&D.

1.4 Innovation and globalization

Technological knowledge loses half its value within three years (Vanini, 1999). In response to needs for fast innovations, the increasing spending on R&D outside of companies' home markets indicates an ongoing trend towards international R&D (Gassmann, 1997) in the quest to be as physically proximate as possible to the sources of technological change.

The internationalization of R&D began when sales activities were moved into target markets during the 1960s-70s and production was moved into low-wage markets. In the 1980s, technical centers were founded to support production and eventually became increasingly active in design and development. They developed their own technological competencies and were eventually capable of conducting increasingly demanding R&D work (Gassmann, 1997). Since the late 1980s, companies have increasingly outsourced basic research projects to joint ventures and leading universities and institutes. R&D processes in the 1990s became more oriented towards international markets and international centers of knowledge, while the competencies and the strength of foreign R&D facilities increased (Gassmann, 1997). In the late 1990s, foreign production facilities and foreign R&D facilities were increasingly separated from one another. R&D became an internationally independent function especially in large companies (Hirsch-Kreinsen, 1999). For increased efficiency, the number of worldwide R&D facilities was then reduced to fewer key R&D centers during the 1990s, while the remaining centers were increasingly integrated within transnational R&D strategies (Gassmann, 1997).

The globalization of R&D has been increasing by a number of different measures. First, at the country level, studies on the origin of industrial patents and surveys of corporate R&D expenditures indicate that between the late 1980s and about 2000, the amount of foreign R&D has risen from about eight to ten percent to about 15 percent for US firms, from four percent to about seven percent for Japanese companies, and from 27 percent to more than 35 percent for European companies, even though about half of R&D internationalization in Europe is intra-European (Zedtwitz and Gassmann, 2002). In 1995, foreign-owned companies accounted for 18 percent of total company-funded R&D in the US, up from 15 percent in 1993.

Some industry groups were allocating particularly large percentages of their R&D budgets to foreign-based R&D: Industrial chemical companies devoted 21 percent of their R&D budget to international R&D, whereas pharmaceutical and machinery companies spent 16 percent and eleven percent respectively (Cheng and Bolon, 1993). By 1995, 676 R&D facilities in the US had been acquired or established by over 350 foreign companies from 24 countries (Serapio and Dalton, 1997). Some companies that have grown significantly by mergers and acquisitions also acquired substantial overseas R&D networks. For instance, ABB conducts more than 90 percent of its R&D abroad, and even before its most recent merger, Glaxo-Wellcome had 65 percent of R&D outside the UK. Other companies have grown by internal expansion. For instance, Novartis established a research center of more than 1,000 scientists in Boston, effectively moving its global R&D headquarters to the US.

R&D is not internationalized uniformly: development usually follows the call of the markets, while research seems to follow technology pull. Because research historically tends to be kept closer to headquarters, foreign R&D investment is more than twice as likely to be development-oriented than domestic R&D investment (for instance in the oil, machinery, automotive, chemicals, telecommunication, food, and diversified products industries). The ICT and electrical industries merely display a moderate tendency towards more domestic research. Only the pharmaceutical industry matches its domestic R&D investment ratio abroad.

Within this context, five principal dimensions of R&D location drivers are distinguished (Zedtwitz and Heimann, 2005): (1) input-related, (2) output-related, (3) efficiency-related, (4) political and socio-cultural, and (5) R&D-external drivers. Input-oriented drivers are concerned with R&D personnel qualification, know-how sourcing and regional infrastructure, factors that are largely outside the direct influence of R&D but necessary for its fundamental operations. Proximity to markets and customers, improvements of image, and R&D collaborations are output- or product-related drivers. They can be chosen or influenced by the company in order to improve the effectiveness of its R&D. Efficiency-related criteria concern the costs of running the foreign R&D unit, of building its critical mass, and of efficiently handing over processes between the R&D and other corporate functions. Political and socio-cultural factors such as local content rules, technology acceptance, entrepreneurship culture, and public approval times also play an important role as drivers of international R&D. R&D-external forces such as a business unit's striving for autonomy and/or local acceptance distract the R&D unit from it's original R&D mission. Such factors may go on unnoticed by headquarters, particularly in strongly decentralized companies. In response, acquisitions are often employed as foreign R&D entry modes to obtain particular technological skills and to gain more efficient access the local innovation system.

All of these drivers, and possibly more, were in play when the locations of the 1,021 R&D locations in a research sample by Gassmann and Zedtwitz (2002) were chosen (Figure 1). The location data reveals a strong concentration of R&D in the Triad Regions of Europe, the United States, Japan, as well as major regional centers in South Korea, Singapore and other emerging economies along the Pacific Rim. The data also shows that research is more concentrated than development. 73.2 percent of all research sites are located in the five regions of the Northeastern USA (New Jersey, New York, Massachusetts), California, the United Kingdom, Western Continental Europe (in particular Germany), and the Far East (Japan, South Korea). The issue of research concentration is even more apparent when only foreign research locations are considered: In this case, 87.4 percent operate in the Triad.

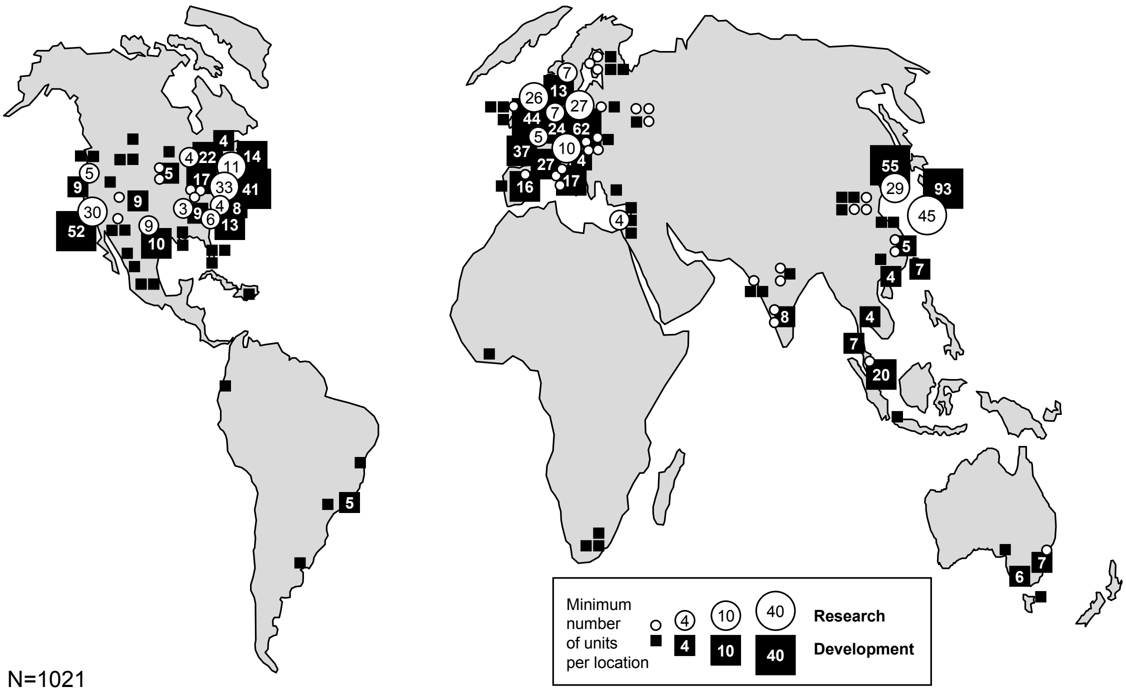


Figure 1: The regionalization of international R&D (Gassmann and Zedtwitz, 2002)

The character of R&D clusters varies from industry to industry, while carrying a historical determinant as well. For instance, Silicon Valley is a cluster of software, IT, and bio-technology companies. Its roots lie in the defense technology spending of the US government. New Jersey (USA) is known for its concentration of pharmaceutical companies. While Bangalore in India is a software but not an IT cluster, the Cambridge (UK) cluster is home to several industries. Some clusters benefit from their virtue of geography rather than a clear industrial profile. For instance, Shanghai quickly emerged as the door to China, attracting large company R&D from many industries. Interestingly, Shanghai became a harbor for many development sites, while pure research laboratories have more recently been established with preference in Beijing (Zedtwitz, 2003). Furthermore, Tokyo's R&D centers made Japan's technology base accessible to Western companies, very much like Japanese companies preferred to establish R&D along the US West Coast and the US Northeast.

1.5 Innovation and lead regions

As indicated above, technology and innovation management may involve (1) the absorption, diffusion and application of existing knowledge, and/or (2) the generation of new technological knowledge. Both may require an R&D presence in a foreign country. The decision to set up R&D in a foreign region usually takes place when the home country alone no longer presents the optimal environment for innovation in the face of a company's global operations. Numerous factors potentially exist to hamper the innovation potential within the home country (OECD, 1996). These factors include (1) excessive risk of conducting R&D locally (i.e. weak intellectual property rights), (2) the cost of doing R&D locally is too high, (3) there is a lack of appropriate sources of intellectual capital, (4) there is a lack of appropriate sources of finance, (5) the pay-off period of innovations generated in the home country is too long, (6) there are deficiencies in the availability of external services, (7) lack of opportunities for co-operation in the home country, (8) lack of infrastructure in the home country, (9) legislation, norms, regulations, standards, taxation restrict R&D, and (10) local customers may be unresponsive to new products and processes. Since the attractiveness of a region for R&D is always a relative measure, home countries may lose attractiveness as foreign regions increasingly develop as global lead regions for new technologies and demand formulation.

Especially as products become more standardized and distribution more global, regions that are considered lead regions play an increasingly important role for globally innovating companies (Jaffe, 1993; Gassmann, 1997; Frost, 2001; Cantwell and Santangelo, 2002), forcing them to increasingly internationalize their innovation activities. Pioneering national innovation systems (NIS), and within them regional innovation systems (RIS) have in numerous cases brought forth such lead regions over the last decades. They are, as indicated above, defined by the presence of world-leading technology and highly demanding consumers (Gerybadze, 1999).

Lead regions have developed along with globalization, and have grown from a traditional dependency on geography-specific production factors (Hirsch-Kreinsen, 1999). By expanding R&D to world-wide lead regions, companies aim to access decentralized knowledge pools and improve the productivity of their innovation activities (Gassmann, 1997). From the market standpoint, different regions worldwide asymmetrically formulate demand, leading to the establishment of local lead markets with especially demanding lead users. From the technology standpoint, innovation increasingly takes place in ‘pockets of innovation’, distinct regions characterized by technology leadership in a certain field encompassing a variety of leading research facilities (Kümper, 1995). The two basic aims of accessing foreign lead markets through international R&D strategies are 1) to use advanced knowledge resources that are either non-existent in the company’s home country, or complementary to knowledge from the home country, and 2) to transfer R&D activities into regions that enable a faster development of innovative products (Hirsch-Kreinsen, 1999). This view corresponds to the model created by Kümmerle (1998), describing international R&D strategies as either ‘home base augmenting’ (HBA), or ‘home base exploiting’ (HBE). HBA indicates that the company seeks to source knowledge from the foreign market that it cannot access from the home base, whereas HBE indicates that knowledge from the home country is transferred abroad to serve a foreign market need. The evolution of the internationalization of R&D describes a development from HBE to HBA, or ‘exploitative R&D’ to ‘explorative R&D’ (Cantwell and Janne, 1999).

Gemünden (2001) indicates that the innovation process consists of market-driven and technology-driven information. As shown in Figure 2, these two knowledge threads originally develop independently from each other. It is the challenge of R&D to use foresight to combine the two threads, creating products that answer to the needs of the market. The two threads eventually merge when an identified market demand is successfully matched to a developing technology (Gemünden, 2001). Combining R&D and marketing in lead regions enables the combing of technology cycles with demand cycles (also referred to as the Customer-Concept-Technology-Interface).

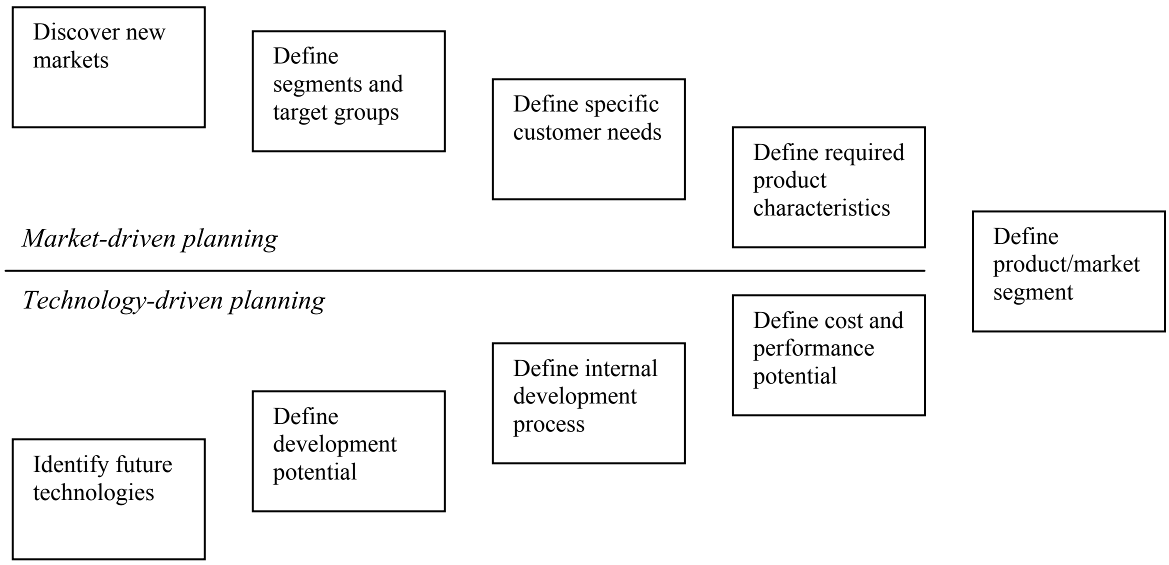


Figure 2: Innovation planning paradigm, market- vs. technology-driven (Gemünden, 2001)

Different projects at different stages of planning constitute the company's technology portfolio strategy. The portfolio is constructed by (1) the identification of technologies, (2) the determination of technology attractiveness for future market applications, (3) the estimation of the time required for the transformation of the technology portfolio, (4) the evaluation of internal resource strength, and (5) the implementation of concrete R&D projects (Bullinger, 1994). The model of innovation promoters (Witte, 1973) sets out to describe innovation processes in companies, and can also be applied to R&D in foreign regions. In this case, foreign R&D managers are needed as promoters to overcome factors of resistance in the innovation process preventing the successful recognition and development of knowledge with the potential of turning into successful innovations. Foreign R&D managers can act as (1) knowledge promoters, (2) process promoters, (3) power promoters, and (4) relation promoters. The theory also relates to the 'gatekeeper model', indicating that local promoters (R&D managers) are needed to gain access to a foreign system of knowledge creation and exchange. This picture describes the necessity of foreign-owned R&D centers to enter into and integrate with RIS (Hirsch-Kreinsen, 1999). Regional conditions for permanent interaction with the economic system are of critical importance here (BMBF, 2001).

The sources of innovation that drive technological change lie within national or regional systems of innovation, referred to in greater detail below, encompassing (1) competitors, (2) suppliers, (3) lead customers, 4) private and public research institutes, and a host of other knowledge carrying organizations (Vanini, 1999). Thus, regardless of the increasing globalization of markets and competition, the impetus of technological change still originates from within local or regional settings. Regardless of improving telecommunications, in the area of R&D, face-to-face communication remains of primordial importance (Kümper, 1995).

Evolutionary economics emphasizes that innovations leading to technological change typically occur in regions with high degrees of technological diversity. This diversity translates into technological opportunities for companies, influencing their ability to innovate and pursue promising technological trajectories (OECD, 1996).

1.6 Innovation and technology forecasting

Technological lead regions offer optimal perspectives for technology scanning and technology forecasting. According to Vanini (1999), the occurrence of technological breakthroughs can usually be forecasted by experts. From the responsibilities of R&D managers to keep up with international pace-maker technologies results the wish to forecast the development of technologies and their complex interdependencies over time. Technology roadmapping addresses these issues as a tool for technology planning (Möhrle and Isenmann, 2002). Technology screening is part of the early stages of an R&D project, implying the absorption of technological knowledge from leading knowledge-hubs, conferences, technology forecasts, expert panels, and the reverse-engineering of competitors' products. Demand-exploration and technology screening are an important source for project ideas (Gassmann, 1997).

Long term technological changes often announce their arrival through weak signals. Different methods exist to measure these, including indicator-methods, model-methods, analysis-methods, information sources methods, and network oriented methods (Bullinger, 1994). Weak signals are analyzed through (1) signal exploration, (2) signal diagnose, (3) forecast of implications of change, (4) signal evaluation (opportunity or threat?), and (5) generation of response options (chances and risks planning) (Bullinger, 1994). Signals originate from (1) the institutional surrounding, (2) the physical surrounding, and (3) the technological surrounding. Sociological and ethical phenomena are also of a high relevance (Bullinger, 1994). Strategic technology monitoring includes: (1) observing technological developments, (2) observing the corporate environment, (3) organizing strategic technology monitoring, (4) setting up administrative bodies, (5) setting up information networks with other actors, (6) using external data sources, and (7) the integrated, cooperative processing of technology monitoring data. This works only in an innovation friendly business environment. The need for technology forecasting has contributed considerably to the formation of transnational R&D networks. In this context, foreign R&D labs are considered to be powerful sensors of technological opportunities (Zanfei, 2000) and hence, the internationalization of MNC technological activities has revolved primarily around the internationalization of research and development (Cantwell, 1995).

1.7 Innovation and transnational R&D networks

With the need to conduct R&D and technology forecasting at different locations throughout the world came the eventual establishment of international R&D networks. In such networks, each R&D location specializes in a certain product group or field of technology. Through an accumulation of knowledge, each location eventually becomes a center of competence and takes on a leadership role in the R&D network. Each competence center may then become responsible for the entire value chain of a product (world product mandate) (Gassmann, 1997). The innovation strategies within these networks are determined by how much of a company's innovation resources lie in foreign subsidiaries, and how integrated the foreign subsidiaries are into global strategies (Kümper, 1995).

Transnational R&D networks enable companies to conduct R&D projects with personnel and/or other resources spread out between different countries, and thus share the R&D workload across borders. Such projects aim to access and utilize decentralized knowledge for the development of new or improved products or processes (Gassmann, 1997). Transnational R&D projects enable a combination of complementary knowledge for the 'sudden interlocking of two previously unrelated skills. An international and interdisciplinary constitution of R&D teams supports the scope of broad and in-depth organizational learning to ensure the future innovation capacity of the company (Gassmann, 1997). Several R&D locations will be involved especially when developing cross-sectoral innovations. Technology-fusions are achieved through a complementary, mostly cooperative process of bringing together non-related technologies or sectors. However, while the existence of foreign R&D subsidiaries improves the chance to create and diffuse innovations within the organization, high levels of competence in several locations makes projects more difficult to coordinate (not-invented-here syndrome, local wish for autonomy, internal competition, etc.) (Kümper, 1995).

The management of R&D projects within global networks may be conducted 'inter-locally' (between R&D locations), or 'intra-locally' (within R&D locations). Determining factors are (1) the type of innovation at stake, (2) the type of tasks required to generate the innovation, (3) the type of required knowledge, and (4) the type of resource pooling required for the completion of the project (Gassmann, 1997). When there is little or no affinity to existing processes or to existing products, the innovation type is considered radical (vs. incremental). The team enters uncharted territory requiring high degrees of autonomy and empowerment. The more radical an innovation, the less concrete the goals of the project, requiring an extensive integration of the project team, in an 'intra-local' environment (Gassmann, 1997). When the individual tasks of the innovation project can be separated from each other, the tasks are 'autonomous (vs. systemic) tasks'. Autonomous tasks imply a larger degree of structure to the tasks, enabling an inter-local organization of the innovation project. Where implicit (tacit) knowledge dominates (for tasks such as coordination and team management, etc.), transnational R&D management becomes especially complex, and face-to-face contact increasingly important (see also: Nonaka, 1991). Implicit knowledge includes experience-based knowledge and social knowledge. The codification of knowledge from the different R&D locations enables a long term benefit of transnational R&D projects. Large degrees of implicit knowledge in innovation projects requires intra-local management. When the complementarity (vs. redundancy) of functions and of resources between different R&D locations is high, then pooling the resources needs to be considered in the organization to avoid duplication costs (Gassmann, 1997). Transnational R&D networks with high levels of functional and asset complementarity thus display higher levels of inter-local innovation projects. In general, the more complex an innovation project is, the more intra-locality is required.

Faster learning of more relevant information is key to explain the internationalization of R&D. Technical 'learning by doing' is the main reason for companies to go through the pains of creating an international network of R&D (Gassmann, 1997). Especially the early phases of R&D projects are marked by the intense transformation of implicit to explicit knowledge (Nonaka, 1991). Early stages of R&D projects are typically intra-local, later stages increasingly become inter-local.

As a theoretical framework to enable an empirical study of foreign-owned R&D facilities in different regional innovation environments, the concept of regional innovation systems is introduced in the next section.

Regional (sub-national) environments have been chosen as a theoretical framework because they are considered to be more relevant than nations to MNC transnational R&D. The dispersed knowledge that enables certain companies to learn faster than their competitors is considered to be bound in geographically concentrated 'systems of knowledge creation' (Lundvall, 1992 and Nelson, 1993). As the globalization and the regionalization of technological change simultaneously progress, nation states are considered to be losing relevance both upwards to supra-national institutions, as well as downwards to regional and local governments and organizations (Ohmae, 1995). Regional innovation systems are therefore receiving increasing attention in the academic literature, as policy makers position themselves to attract foreign direct R&D investment (Gerybadze, 1999), and MNC seek to maximize their leverage of regional innovation potential within multi-regional R&D networks.

1.8 Innovation and regional innovation systems

The definition of regional innovation systems (RIS) begins with a definition of national innovation systems (NIS). Three types of national systems determine the regional attractiveness for transnational R&D: (1) the national innovation systems (structures and processes of research, innovation and technology policy), (2) the national systems of demand-formulation (where is customer demand most developed as an incentive for companies to bundle innovation activities), and (3) the national system of political-administrative implementation (national structures and forms of organization, political and legal stability, organizational competence of different locations) (Gerybadze, 1999).

The innovative activity seen from a systems perspective can be measured by identifying the proportion of firms that are ‘innovating’ as opposed to ‘not-innovating’. The potency of the system of demand formulation can be measured by the percentage of sales derived from new or improved products (OECD, 1996). The Political-administrative system can be judged by examining which policies effect industrial innovation and how. According to Archibugi and Immasino (1999), exploiting the full potential of globalization of innovation would necessitate a far wider range of supportive public policies than those currently practiced in the majority of countries.

Innovation is a complex and systematic phenomenon. Systems approaches to innovation emphasize the interplay between different knowledge carriers and diverse institutions, both in the creation of knowledge and in its diffusion and application. The NIS is defined as: ‘the sum of actors and structures in a country that drive or influence the creation, diffusion and market application of knowledge and new technology. This includes not only research sites and industry laboratories but also the political administration, intermediary institutions and other networks, the educational system, the legal framework and structures of the financial market’ (Lundvall, 1992; Nelson, 1993 in BMBF, 2001). Vanini (1999) adds ‘competitors, suppliers, and customers’ to the sum of actors, the OECD (1996) adds structural elements such as ‘value systems, and social and cultural practices’. NIS theory has provided policy makers and managers with insight on how to enable and promote innovative activity in national and regional contexts. The systems view of innovation emphasizes the importance of the transfer and diffusion of ideas, skills, knowledge, information, and signals of many kinds. The channels and networks through which this information circulates are embedded in a social, political and cultural background, they can be enhanced or constrained by the institutional framework.

When the sources of innovation such as scientists, customers, suppliers, partners, and competitors, appear to be regionally clustered at sub-national levels and at different locations throughout the world (Cantwell, 2001), these clusters constitute regional innovation systems that can be explained by the fact that tacit knowledge, which in many cases is critical to the innovation process, is expensive to transfer over geographic distance. Within NIS, the hubs of innovation thus lie within regional, sub-national agglomerations of economic activity. Bergman (2001) considers RIS to be the drivers of NIS. Access to specialized labor, regional knowledge networks, and transfer cost economies provide positive agglomeration externalities such as knowledge spillovers, representing a regional innovative milieu (Aydalot, 1988) with the ability to foster and facilitate innovation. Regions in this context are also described as competence blocs (Eliasson, 2002) that enable the development and commercialization of knowledge, and the ensuing growth of local firms. Such regions are characterized by a geographic concentration of networked firms that are stabilized by the institutional structure of the region. The economic performance capability of regional agglomerations is derived from structurally and institutionally condensed processes of cooperation and learning (Hirsch-Kreinsen, 1999). Regional agglomerations depend on the internationalization of their own innovation systems in order to remain competitive versus other leading regions. Failing to internationalize the regional innovation systems from a policy perspective would lead to a vicious circle of loss of scientific and technological competencies and a loss of economic competitiveness (BMBF, 2001).

Regions characterized by the presence of many small and innovative companies representing a breeding ground for innovation (Saperstein and Rouach, 2002), constitute entrepreneurial technological regimes (Winter, 1984). The small companies contribute to a widening of innovation (Schumpeter, 1934), making them attractive for acquisition by multinational companies. Once the small company knowledge has been absorbed, a deepening of innovation sets in. The routinized technological regime then takes over, characterized by large companies, incremental innovations and economies of scale.

Since the actors and networks that enable innovation in regional environments are embedded in social, political and cultural backgrounds (OECD, 1996), each region has a specific 'embeddedness of economic activity' (Granovetter, 1985) which gives a distinct flavor to innovation practices in a given region. As expressed by Freeman (1987), regional networks form highly specific innovation contexts or systems. Each RIS has its own institutional endowment (Maskel and Malmberg, 1999), implying unique rules, practices, routines, habits, traditions, customs, and conventions associated with regional supplies of production factors. The worldwide heterogeneity and specificity of RIS can be explained by the evolutionary and path dependent dynamics of regional technological regimes over time (Antonelli, 1999): It seems that generations of economic activity have created a wide variety of regional species of innovation environments which today, in our globalized world, all contribute to global technological change.

When constructing transnational R&D networks, multi national companies (MNCs) thus need to adopt regionally specific approaches to gain effective and efficient access to the knowledge within RIS. However, the process of gaining such access may be complicated by the liability of foreignness (Hymer, 1960) that MNCs are confronted with when setting up activities abroad. Understanding the implications of liability of foreignness in different regions is an important prerequisite for successful multi-regional R&D, enabling companies to chose appropriate entry modes as well as post entry integration strategies.

The distinctly different character of RIS is examined for instance in the well known work by Saxenian (1994) comparing Silicon Valley with Boston's Route 128. Regional 'network based industrial systems' are organized around horizontal networks of firms. Network systems flourish in regional agglomerations where repeated interaction builds shared identities and mutual trust while intensifying corporate rivalries. According to Saxenian (1994), most strategic relationships in such systems are local because of the importance of timeliness and face-to-face communication for rapid product development. The concept of agglomeration and external economies however cannot explain why clusters produce a self-reinforcing dynamic in certain regions while underlying decline in others (Saxenian, 1994). The system's decentralization encourages the pursuit of multiple technical opportunities through spontaneous regroupings of skill, technology, and capital. Its production networks promote a process of collective technological learning that reduces the distinction between large and small firms, and between industries or sectors.

On the other hand, regional 'independent firm-based industrial systems' flourish in an environment of market stability and slow-changing technologies (Saxenian, 1994). Their leading producers benefit from the advantages of scale economies and market control. This system is easily overwhelmed by changing competitive conditions, as it may find itself locked into obsolete technologies and markets. Companies' inward focus and vertical integration limit the development of a sophisticated local infrastructure. The system's firms may continue to produce breakthroughs, but do not enable the region as a whole to participate in these breakthroughs.

1.9 Innovation and foreign RIS entry

Companies wishing to enter into a foreign RIS with an R&D unit must become an integral part of the local innovation terrain. This is the case especially when the type of R&D to be conducted requires large amounts of locally bound, tacit knowledge, and when market conditions call for co-operative R&D. When R&D facilities intend to gain access to foreign sources of innovation (knowledge) that lie within a foreign regional innovation system, they need to establish interfaces between the corporate and the regional innovation systems. This implies finding out where (within which knowledge carriers) the locally sought knowledge lies bound, and how to set up the interaction between the foreign R&D facility and the external sources of innovation. So, once again, the idea is to find ways to integrate regional and corporate innovation systems.

A corporate innovation system, depending on the individual company and the extent of formalization of its innovation processes, might include a company's global research and development facilities, its sales and marketing facilities, its production facilities, its customer service facilities, as well as far-ranging networks of external partners and service providers that contribute in the widest sense to the company's innovation process. From the perspective of the foreign region, the local R&D facility can be considered the visible 'tip of the corporate innovation system iceberg'. Researching the interaction between corporate and regional innovation systems to a large part implies researching the interaction between foreign-owned R&D facilities and the regionally bound knowledge resources in regional innovation systems throughout the world.

In its adapted form, the 'innovation policy terrain' (see Figure 3), a conceptual framework originally designed by the OECD (1996) for the development of innovation policy, shows the elements of regional innovation systems as a basis for planning R&D entry into a foreign RIS.

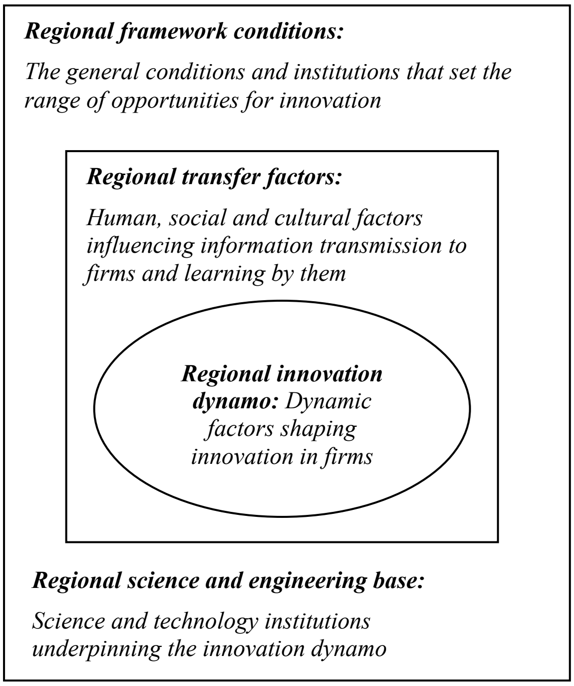


Figure 3: The innovation terrain, adapted from OECD (1996)

Adopting an innovation terrain view of RIS brings into focus four elements of key importance to foreign R&D investments: (1) the regional framework conditions, (2) the regional science and engineering base, (3) the regional transfer factors, and finally (4) the regional innovation dynamo – the region's population of innovative firms. Foreign companies wishing to conduct R&D abroad by becoming part of the regional innovation dynamo need to understand and find access to the regional framework conditions and regional science and engineering base. This process of understanding and gaining access to is aided by the regional transfer factors. Transfer factors determine the effectiveness of linkages, flows of information and skills, and absorption of learning, and are essential to business innovation. The components of the transfer factors include (OECD, 1996):

- Formal and informal linkages between firms, including networks of small firms, relationships between users and suppliers, and networks of firms, regulatory agencies and research institutions. These networks produce information flows conductive to innovation or adding to the receptiveness to innovation.

- Personal networks between individuals, so-called expert technological gatekeepers who keep abreast of new technological developments and maintain personal networks that facilitate flows of information and can be crucial to innovation in the firm.
- International links through which information is directed. Networks of international experts are important means to transmit up-to-date scientific understanding and leading-edge technological development.
- The degree of mobility of expert technologists or scientists, the ease of industry access to public R&D capabilities, and the ease of spin-off company formation.
- Codified knowledge in patents, specialized press and scientific journals.
- Ethics and community value systems, including factors such as trust and openness which influence the extent to which networks, linkages and other channels of communication can be effective by defining the informal dealings between individuals and setting the parameters for communication and information exchange.

Entering into a foreign RIS necessitates companies to analyze each of the components of the innovation terrain, especially the transfer factors, because ultimately, these factors will enable the foreign-owned R&D facility to exchange knowledge with local knowledge carriers to accomplish the foreign R&D mission. As indicated above, RIS vary considerably from each other, so that companies must identify the innovation terrain that best fits to their R&D needs. The location decision depends to a large extent on the compatibility between the RIS and the corporate innovation system (CIS). To illustrate this concept of compatibility, the following sections present a conceptual model as a starting point for the evaluation of whether a RIS and a CIS are compatible enough to justify an R&D investment.

To be compatible with the RIS and successfully gain access to regionally bound knowledge resources, the foreign-owned R&D facility must activate interfaces between the CIS and the RIS, enabling the company to internalize external knowledge in the foreign environment. Activating these interfaces extends the company's absorptive capacity (Cohen and Levinthal, 1990) to the given foreign R&D environment and the conducting of R&D within such an environment. The methods with which companies enter into and integrate with a regional innovation systems are discussed and empirically verified in this study. Below, the concept of compatibility between corporate and regional innovations systems is discussed in greater depth. Before this is done however, the following section discusses liability of foreignness as a determinant of the cost and effort associated with setting up R&D abroad.

1.10 Innovation and liability of foreignness

The concept of 'liability of foreignness' (Hymer, 1960; Kindleberger, 1969; Caves, 1971; Buckley and Casson, 1988) is rooted in transaction cost theory (Coase, 1937). It claims that foreign companies' transaction costs are greater than those of their domestic counterparts. Applied to foreign-owned R&D the theory states that gaining access to, understanding, and leveraging external foreign knowledge is more costly when done to abroad than when doing so in ones home country. As shown in Figure 4, LOF is driven by social and cognitive access barriers (Lorenzen and Mahnke, 2002). Social access barriers make it costly to gain access to and collaborate with the foreign innovation systems' sources of innovation, largely due to discrimination of foreign players, whereas cognitive access barriers make it costly to understand and leverage foreign knowledge due to local specificities of knowledge sharing and transfer mechanisms. Social and cognitive access barriers may thus determine the 'cost of setting up and conducting R&D abroad'. LOF theory explains why only selected international interactions are handled through foreign direct investment (Hennart et al., 2002): the rents need to be sufficient to offset the cost of doing business abroad (Caves, 1971).

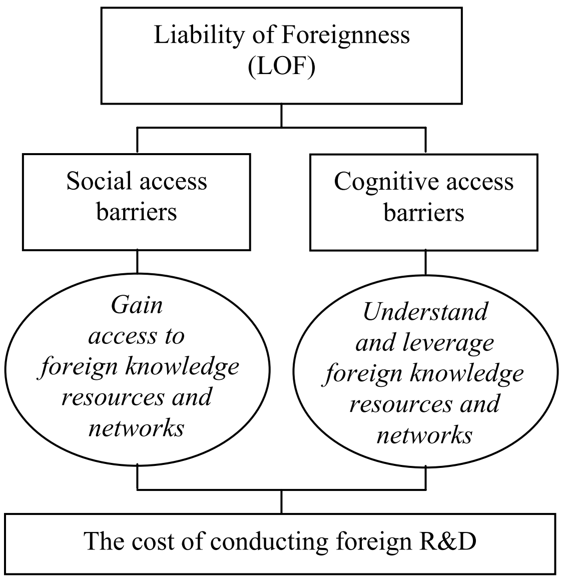


Figure 4: Liability of foreignness and the cost of conducting foreign R&D

Spatial distance between the parent and the subsidiary, cultural and language differences, unfamiliarity with the host country environment and government policies, economic nationalism, and trade restrictions, are commonly cited as components of LOF (Eden and Miller, 2001; Matsuo, 2000; Sethi and Guisinger, 2002; Zaheer, 1995). The resulting lack of local understanding and lack of local legitimacy may be costly to mitigate.

The mitigation of LOF with the goal of reducing the cost of doing foreign R&D can take on defensive or offensive forms, or combinations of both (Luo, Shenkar, and Nyaw, 2002). Defensive mitigation implies reduced vulnerability of the foreign entrant through (1) contract protection, (2) parental control, (3) parental service, and (4) output standardization. Offensive mitigation implies enhanced local adaptation of the foreign entrant to its local surrounding through (1) local networking, (2) local resource commitment, (3) local legitimacy improvement, and (4) local input localization. Due to foreign R&D's potential dependence on external knowledge, offensive forms of mitigation may be of central importance when foreign-owned R&D units aim to understand, gain access to, and leverage knowledge in foreign innovation systems.

The theory of liability of foreignness, as mentioned above, dates back to the 1960s. The degree to which foreign-owned R&D centers find themselves at a local disadvantage due to LOF is driven on the one hand by the capabilities company itself, and on the other hand by the environment in which it is foreign and trying to conduct R&D (Mezias, 2002). In general terms, companies are less vulnerable to LOF when they (1) are financially strong enough to 'buy their way in' to the local innovation system, (2) have a strong international brand and reputation that local players want to be associated with, (3) offer the local players excellent technology in return for access to the local innovation system, (4) are experienced at conducting R&D and non-R&D activities internationally in foreign countries, and (5) when they have extensive international networks (such as distribution channels), which local players want to gain access to. Furthermore, the degree of LOF experienced by a company may depend on its international experience in general, and its experience with the region of entry in particular (Chang and Rosenzweig, 2001; Petersen and Pedersen, 2002).

Taking on a resource-based view, Sethi and Guisinger (2002) find that the mitigation of LOF requires (1) an accurate reading of the business environment, (2) the formulation of a mitigation strategy, and (3) an implementation of this strategy. Thus, their view extends beyond the initial entry mode decision to a company's on-going foreign operations. To minimize the cost of mitigating LOF, companies establish linkages with local players that help them read the business environment, formulate compatible integration strategies, and implement these strategies in their host country environments (Sethi and Guisinger, 2002).

1.11 Conceptual model: compatibility between RIS and CIS

Information and knowledge in industrial clusters circulate are embedded in a specific economic, social, political and cultural background (Granovetter, 1985 and OECD, 1996). The resulting 'embeddedness of economic activity' (Granovetter, 1985) gives a distinct flavor to knowledge creation and exchange practices in each region. As expressed by Freeman (1995), regional networks form highly specific innovation contexts or systems. As indicated above, the heterogeneity and specificity of RIS can be explained by the evolutionary and path dependent dynamics of regional technological regimes over time (Antonelli, 1999). To local insiders, tight regional embeddedness promotes the transfer and diffusion of knowledge (Uzzi, 1997) while enabling regions to develop a distinct culture around trust relationships. To foreign outsiders, the embeddedness issue may present a cost or at least needs to be approached in a systematic way. To enable participation in embedded environments, companies must enter into and integrate with the local innovation terrain (referred to here as the integration of corporate and regional innovation systems), thus creating compatibility between the two systems. Tight regional integration of the foreign R&D unit is essential to enable efficient and sustainable interaction within the local knowledge environment (BMBF, 2001).

1.11.1 Introduction to compatibility

Both the literature and the empirical data gathered for this study indicate that foreign-owned R&D, more often than not, benefits from a tight integration with the foreign knowledge environment. There thus is a case for believing in the relevance of a model to describe the integration of corporate and regional innovation systems (CIS and RIS). This integration may in fact be one of the major challenges of foreign R&D management. The literature however, lacks models to explain such an integration phenomenon. As the empirical data in this study will show, the process involves various dimensions of integration that ultimately lead to compatibility between the two systems. The outset of the integration process is determined to a large extent by the characteristics of the RIS and the CIS. Furthermore, the process is implemented by identifying interfaces between the two systems, and by selecting networks to activate these interfaces. With an understanding of the characteristics of the RIS as it relates to foreign-owned R&D, as well as the interfaces and networks that enable compatibility, companies can extend their R&D's absorptive capacity to the foreign RIS by being able to fully leverage regional knowledge resources. To increase the absorptive capacity, integration initiatives can be additionally conducted to facilitate the exchange of knowledge between the two systems. The model is indicated below in Figure 5. Its components will be discussed in greater detail further below.

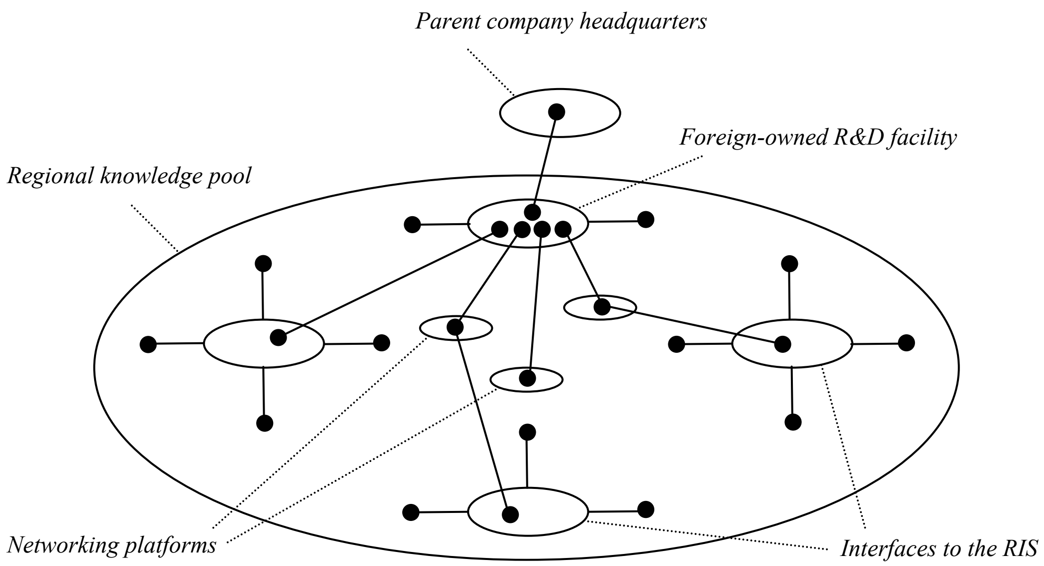


Figure 5: Using interfaces and networking platforms to access regional knowledge

The interfaces to the RIS give the foreign-owned facility access to regionally bound knowledge. They can be supplier companies, customer companies, end users, complementary technology companies, competitor companies, universities, state research labs, or diverse service providers. Networking platforms are organizations with an explicit interest in enabling knowledge exchange in the RIS. They will thus set up infrastructures aimed at facilitating the integration of such foreign R&D facilities.

1.11.2 The company as a determinant of the integration process

Large, global companies may find it easier to move into foreign environments than smaller, less internationally experienced companies. The difficulty and potential cost of the integration process for a particular company may depend on (1) its degree of internationalization, (2) its existing local markets and networks, (3) its international brand equity, and (4) its capital strength. A fast and inexpensive integration is possible when local players are interested to gain access to global markets by interacting with the company's local R&D facilities, when local players prefer interacting with foreign companies that are already known in the local market and in local knowledge networks, when local players are interested to leverage their own brands by interacting with a foreign R&D facility with strong international brands of their own, and when local players are attracted to interact with foreign R&D facilities that offer strong financial incentives to interaction. In brief, these factors indicate that large, global companies may find it easier to integrate with RIS than small, less internationalized companies. The company's absorptive capacity in this case determines how well the company is able to integrate with the foreign knowledge environment.

1.11.3 The region as a determinant of the integration process

The cost and effort required to enable integration with the RIS also varies between regions. Regions may be culturally proximate or culturally distant from the culture of the company evaluating an R&D investment. The more proximate the two cultures, the easier it may be to achieve integration. Regional legislations and cultures may vary in terms of how much they are (1) in favor of international R&D investment, and (2) willing and able to support foreign company's efforts to prepare for and execute regional investments. In addition, regions may vary with respect to general private and public infrastructures available to enable and facilitate regional integration of foreign R&D facilities. Networking platforms and service providers such as industry associations, technology clubs, academic networks, consultants, and even advertising and public relations providers may play an important role in facilitating the integration of foreign R&D and may be available to differing degrees in different regions. The region's absorptive capacity in this case determines how well the region is able to integrate foreign companies into its knowledge environment.

1.11.4 Compatibility and the cost of integrating abroad

The above paragraphs formulate that there are company-driven and region-driven components that determine the cost and effort to be expected in the regional integration process. The idea is that there must thus be some sort of company absorptive capacity that goes hand in hand with a regional absorptive capacity, the two of them together characterizing the cost associated with the integration process. At the outset of the integration process however, the fit (or misfit) between the CIS and the RIS represents a base-compatibility as a starting point for the integration process. Figure 6 shows the cost of integration as a function of this base-compatibility, determined by company and regional absorptive capacities.

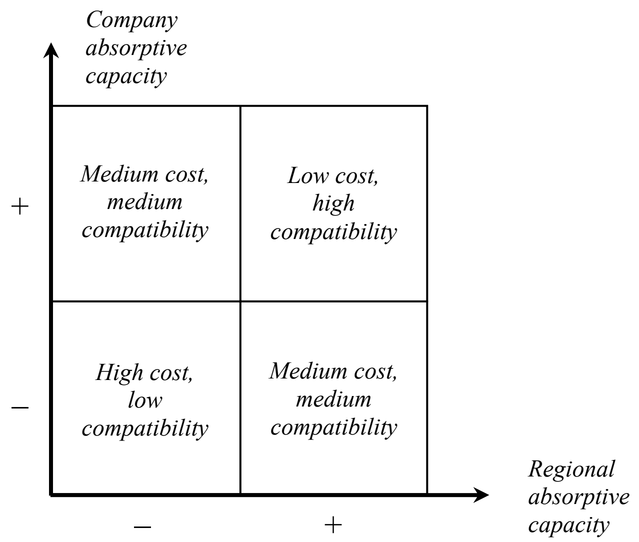


Figure 6: Compatibility, regional and company absorptive capacities, and cost of integration

According to Figure 6, the less internationally absorptive the company and the region are, the more the foreign company will have to invest into integration initiatives to offset lacking base-compatibility. In cases with low base-compatibility, the cost of integration may play a key role in international companies' R&D location decisions.

1.11.5 Creating compatibility as a foreign-owned R&D facility

Foreign-owned R&D facilities can create compatibility by pursuing integration initiatives. The pursuit of compatibility begins with an understanding of base-compatibility. To understand base-compatibility, facilities need to know the characteristics of the RIS as it relates to foreign-owned R&D. This implies understanding the anatomy of the RIS and the associated opportunities for knowledge exchange. The anatomy of RIS as a basis for the empirical study in this research will be discussed in detail further below. The facility must then decide on how to enter into the RIS, and on how to integrate with the RIS. The variables for entry include the chosen entry mode, the nationality of the R&D facility manager, and the financial commitment made to the region. The variables for integration include the interfaces chosen to gain access to regionally bound knowledge as well as the networks employed to activate these interfaces. All of these variables are discussed in detail further below.

The process of creating compatibility may involve using services referred to as integration facilitation services. These services may originate from public or private regional bodies and are aimed at facilitating the regional integration initiatives of the foreign R&D facility. Facilitation services are used to a varying degree by companies setting up R&D abroad. Private services for regional integration facilitation span a wide range of offers from consultants, private networking organizations and associations, industrial and non-industrial clubs, head hunters, and PR and advertising agencies. Public integration facilitation services are typically offered by inward investment agencies, regional development offices, departments of trade and commerce, foreign trade liaison offices, university corporate liaison offices, and university technology transfer offices. Services from the public domain are typically free of charge while private services present a cost to the foreign company. Governments may grant financial incentives such as tax breaks or other incentives to foreign companies to support FDI. Foreign companies may use a mixture of public and private services to facilitate their regional integration initiatives.

The eclectic theory of FDI, also referred to as the OLI paradigm (Dunning, 1995), raises the question of ownership of foreign operations, the question of such operations' location, as well as the question of which entry mode to choose for the operations. The location-bound host country advantages (Harzing, 2002) implied by the global, asymmetrical dispersion of the knowledge required for R&D implies that certain geographic regions indeed offer a distinct locational advantage for international R&D. The often tacit and proprietary character of innovation furthermore implies an advantage of ownership, calling for FDI instead of non-equity transactions. The question of entry mode remains. Which are the specific advantages of different entry modes with respect to entering and integrating with RIS? The following section gives an overview of literature on entry mode decision rational.

1.11.6 Compatibility and entry mode decisions

Companies can become active abroad in numerous ways. Internationalization theories quote export, foreign trade, licensing, partnerships, and alliances as non-equity-based foreign entry, and greenfield (GF) investments, acquisitions (AC), and joint ventures (JV) as equity-based foreign entry (Kogut and Singh, 1988). This research focuses of the second group, as international R&D most commonly involves some sort of ownership of the foreign operations. Equity-based entry modes are commonly referred to as foreign direct investment (FDI). Within the group of equity-based entry modes, this research furthermore includes university spin-ins (US), and add-on investments. University spin-ins indicate that companies may place R&D facilities within a foreign university's facilities to be especially proximate to the research going on there. Add-on investments indicate that R&D operations may be places in proximity to existing parent company operations in the target country, as to benefit from existing infrastructures and networks. In sum, the entry modes discussed in this section are (1) greenfield investments, (2) acquisitions, (3) joint ventures, (4) university spin-ins, and (5) add-on investments. As shown in Figure 7, these entry modes can be divided by two dimensions. First, there is the 'proprietary approach' of greenfield investments, acquisitions, and add-on investments (full ownership), versus the 'joint approach' of joint ventures and university spin-ins (joint ownership). Second there is the 'make or buy' question: whereas greenfield investments and add-on investments are clear cases of 'make' and acquisitions are clear cases of 'buy', joint ventures and university spin-ins are intermediary in this respect. They imply that by reciprocity by working together with a foreign company or university. For these intermediary entry modes I use the term 'collaborate'.

Equity-based entry modes			
Full ownership		Joint ownership	
‘Make’	‘Buy’	‘Collaborate’	
Greenfield & add-on investments	Acquisitions	Joint ventures	University spin-ins
Build knowledge resources	Integrate knowledge resources	Coordinate knowledge resources	

Figure 7: Equity-based entry modes and their characteristics

Greenfield investments and add-on investments require foreign R&D managers to *build* a new presence and new knowledge resources, possibly from scratch (in the case of greenfield investments). Acquisitions require an *integration* of the acquired company, retaining key personnel and retaining access to the regional innovation system. Joint ventures and university spin-ins require a *coordination* with local partners to prevent opportunistic exploitation and manage possible conflicts of interest. The foreign R&D manager needs to master these ‘external’ challenges in addition to the ‘internal’ challenges posed by managing an R&D entity in a foreign country, such as the not-invented-here syndrome, lacking share-of-mind by headquarters, information asymmetries, and other internal challenges.

Theoretical and practical views of which types of entry modes should be selected by which types of international R&D initiatives vary widely. In many, if not most cases of R&D internationalization, there is in fact no such thing as an ‘entry mode decision’. Often, greenfield labs are found where there is simply no alternative (i.e. because no acquisition candidates were available at the time of entry). Similarly, acquisitions are often found were no alternatives were present (i.e. entire companies are bought, including their R&D facilities). In these cases, there is no conscious entry mode decision for the foreign R&D facility. Entry modes in these cases are given. However, this is not always the case. Companies do in fact also go through conscious decision processes involving the entry mode decision before internationalizing their R&D. To gain insight into the factors that make up these decisions, the entry mode literature is reviewed and applied to the internationalization of R&D below.

The entry mode decision can be described in theory by different trade-offs. These trade-offs include (1) control versus speed and flexibility trade-offs, (2) control versus cost of resource commitment trade-offs, and (3) potential value versus set up costs trade-off.

According to trade-off number 1, joint ownership entry modes may be faster and more flexible than proprietary entry modes. However, they also imply a lesser degree of control over the dissemination of proprietary assets. According to trade-off number 2, greenfield investments may offer high levels of control over dissemination. However, they may also necessitate greater resource commitment than joint ownership entry modes. According to trade-off number 3 (which is similar to trade-off number 2), the wish to reap the greatest potential value from a foreign R&D investment at the same time implies that greater set-up costs must be taken into account. This trade-off implies that total intellectual property (IP) ownership may inevitably be linked to proprietary (and thus more costly) entry modes. In theory, acquisitions seem to potentially offer speed, flexibility, and control at once. However, they typically offer less control than greenfield investments (key personnel may leave after the acquisition, taking knowledge with them), and less flexibility and speed than joint ventures (acquiring an existing company implies taking over an organization with existing assets, structures, and capabilities. Adapting these to the needs of the acquiring company in order to achieve the same degree of control that a greenfield investment would offer, may prove costly and time consuming.). This last consideration contains elements of all three of the trade-offs described above. In any case each entry mode entails different management challenges as portrayed in Figure 7 above.

Hence, greenfield R&D investments risk failure if the foreign company fails to build local knowledge resources and access to the regional innovation system. R&D acquisitions risk failure if the foreign management fails to integrate and adapt the acquired company to its strategic R&D needs. R&D joint entry modes risk failure if the foreign company fails to coordinate efficiently and effectively with the knowledge resources of the local partner. Most of the literature on entry mode decisions takes on either resource-based, or transaction cost perspectives. In both cases, the correct entry mode is considered to be a function of mission and strategy as well as other firm characteristics, industry characteristics, and regional characteristics.

From both the resource based and transaction cost based perspectives, trust is a critical factor in the entry mode decision process (Kümper 1995). This applies to internal trust within the global company, as well as external trust between individuals of the company and the potential R&D collaboration partners in the host country. When there is mistrust, the coordination of international R&D is more likely to be conducted through proprietary subsidiaries as opposed to jointly owned subsidiaries.

1.11.6.1 Make or buy entry mode decisions

The resource-based view examines who holds key resources at the time of entry in the region of entry and how much it would cost to acquire and integrate them. From the resource-based perspective, strategic intent predetermines its entry mode as the means to gaining access to key resources at minimal cost. The resource-based perspective distinguishes between (1) knowledge resources of the investor, (2) knowledge resources held by local players, and (3) knowledge resources on the open market. In this context, a distinction is made between 'market-seeking' and 'resource-seeking' companies (Meyer and Estrin, 1999). This view correlates to some extent with the HBA/HBE model by Kümmerle (1998) as described above. Market seeking companies depend on access to local customers, market intelligence, and distribution networks. Resource seeking companies depend on locally bound human knowledge capital for their R&D operations. In this context, greenfield investments are common for companies with a strong competitive advantage (Kim and Lyn, 1987), whereas acquisitions are more common for companies that are highly dependent on fast access to local knowledge and knowledge networks. In this sense, Meyer and Estrin (1999) propose that acquisitions are more likely when the local industry possesses assets that are valuable to foreign investors and if incumbents in the industry are protected by high barriers to entry. Further propositions relate to the resources available on the open market: To engage in a greenfield investment, local resources must be available outside of existing local firms and organizations. Meyer and Estrin thus propose that entry into a country with a low quality or quantity of resources available on free markets (e.g. skilled labor, real estate), relative to those available in firms, is more likely in form of acquisition. Greenfield investments are preferred by firms that develop their capabilities internally (Kogut and Zander, 1993). Firms with transferable resources (e.g. public good character competencies, excess management, access to finance), are more likely to chose greenfield investments than acquisitions.

When transaction cost considerations are brought into the resource based view, it is possible to distinguish between (1) costs for acquiring corporate control, (2) costs for acquiring complementary resources from the open markets, and (3) costs of adaptation and integration of acquired resources. The less efficient the markets for corporate control and the open markets are, the more likely greenfield investments become. When the cost of adaptation and integration is high, greenfield investments become more likely. The level of experience a company has with international operations is also relevant in this respect: the more experienced with acquisitions a company is, the more likely it is to enter via acquisition. The same may apply to greenfield entry. In general, the literature suggests that companies chose the entry mode that minimizes the transaction costs associated with the acquisition, adaptation, integration, and on-going coordination of its critical resources. For example, Kogut and Singh (1988) show that cultural distance increases the probability of companies to conduct greenfield investments rather than acquisitions. The explanation may be found the cost of integration that rises with increasing cultural distance.

The point has been made that greenfield investments offer a larger degree of control than acquisitions. With respect to the make-or-buy decision, companies with higher R&D intensities prefer entry modes with higher levels of control. Thus, in accordance with this view, research by Andersson and Svensson (1994), and Caves and Mehra (1986), indicates that increasing R&D intensity increases the probability of greenfield investments over that of acquisitions. Hennart and Park (1993) furthermore indicate that the propensity to conduct greenfield investments versus acquisitions rises with the importance of firm-specific assets. Opinions on whether acquisitions or greenfield investments are faster vary. Meyer (2001) shows that greenfield investments may be too slow if a first-mover advantage is sought.

1.11.6.2 PROPRIETARY OR JOINT ENTRY MODE DECISIONS

The transaction cost perspective puts forth the default hypothesis 'lower resource commitment is preferable until proven otherwise'. For instance, Hennart (1988) indicates that based on transaction cost considerations, joint ventures are avoided unless transaction costs are very high and full internalization is not feasible. Kogut and Zander (1993) indicate that the cost associated with transferring tacit knowledge favors internal coordination over external coordination. According to the transaction cost consideration put forth by Anderson and Gatignon (1986), the most efficient entry mode is a function of the trade-off between control and the cost of resource commitment. This trade-off describes that greater control (in the form of full ownership) necessitates higher levels of resource commitment. The factors determining entry mode decisions in this context are: (1) transaction-specificity of assets (2) degree of external uncertainty, (3) degree of internal uncertainty, and (4) free-riding potential. Below, these factors are applied to foreign R&D.

Highly transaction-specific assets make internalization (full ownership) preferable to external collaboration (joint ownership). The specificity of key assets is not reduced until the innovation diffuses in the marketplace, and the transaction-specific assets become general purpose assets (Chandler, 1977). High transaction-specificity of assets thus calls for greater control and greater resource commitment. Williamson (1979), claims that companies should react to volatility by avoiding ownership. Thus, external uncertainty implies that joint ventures may be preferable to full ownership. However, Anderson and Gatignon (1986) suggest that when paired with increasing asset specificity, external volatility calls for increasing, not decreasing control. Both volatile external environments and highly specific assets are characteristics of many technology intensive industries. External uncertainty in such industries thus also calls for control and resource commitment. Internal uncertainty relates to principal-agent issues. With large cultural distance between principal and agent, Anderson and Gatignon (1986) suggest either (1) low levels of control if there is no distinct advantage in doing business the entrant's way, or (2) high levels of control if there is a distinct advantage in doing business the entrant's way. Socio-cultural and spatial distance thus do not necessarily constitute arguments in favor of increasing control and resource commitment. Companies with high R&D intensities risk exploitation by free-riders (Meyer, 2001), calling for increased control through internal coordination. This may be the case especially in regions offering low intellectual property rights (IPR) protection. Smarzynska (2000) finds the risk of free-riders to be limited when a sufficient technology gap between the entrant and its local partners is present. Ethier and Markusen (1996) however find that by way of employee turnover, knowledge dissipation eventually occurs regardless of initial entry mode. In any case, collaborating with a local company in the form of a joint venture may speed up the process of gaining access to, and learning to understand, local knowledge (Lorenzon and Mahnke, 2002) however at the cost of less control.

The default hypothesis suggests that companies should prefer speed and flexibility to control, meaning that they should prefer joint-ownership to full ownership. However, with increasing spatial and cultural distance, joint ownership becomes increasingly difficult to coordinate and adapting and integrating acquired assets increasingly expensive. Nonetheless, companies with considerable international experience are more likely to chose entry modes offering increased speed and flexibility due to their capability to manage complex projects across spatial and cultural distance. High-control entry modes even if not entirely desirable, may find their main purpose in protecting IPR and compensating for lacking integration and coordination skills.

The above observations indicate that foreign R&D may call for more, rather than for less control as formulated by the transaction cost perspective ‘lower resource commitment is preferable until proven otherwise’. Joint R&D entry modes providing greater flexibility and speed at lower levels of resource commitment are attractive in theory, but require large amounts of management experience while risking free-riding or even opportunistic exploitation. In general, ‘technology leaders’ will be more capable of conducting joint ventures than ‘technology laggards’ (Smarzynska, 2000). The more serious the interest in a region’s knowledge resources and the more critical these resources are to a company’s competitive advantage, the more resources the company will be willing to commit in order to gain control and higher potential return.

In conclusion for both the make-or-buy as well as the proprietary or joint decisions, the strategic intent of the R&D investment often predetermines its entry mode. The type of resources sought varies with the strategic intent, for instance for market-seeking and resource-seeking investments. The strategic intent also implies whether high or low levels of control will be needed, and greater resource commitment and lower flexibility justified.

1.12 Empirical study

This research examines (1) the characteristics of foreign-owned R&D at five locations throughout the world (Beijing, London, Cambridge (UK), Stockholm, and Munich), as well as the sample’s 62 foreign-owned R&D facilities’ behavior concerning their (2) entry into and (3) integration with the respective regional innovation systems. Implications for policy makers and R&D managers are given as a conclusion throughout Section 4. An overview of the empirical study is given in Table 1 below.

In Section 2, as an introduction to the regional analysis, regional typologies of the five locations are developed based on the six generic building blocks of RIS that will be presented in detail below. The idea is to show the heterogeneity between these locations as an important driver influencing the types of foreign R&D they attract. The typologies briefly describe the evolution and the current state of each of the locations' regional innovation systems.

Section 3 presents of the variables that will be examined in the empirical study in Sections 4-6. It furthermore formulates, based on the variables presented in the section, the MMB (mission, motive, behavior) model, aimed at enabling the characterization and comparison of foreign-owned R&D facilities world-wide. The MMB model gains special relevance when comparing foreign-owned R&D facilities in different regions, while at the same time indicating global patterns in the internationalization of R&D.

Section 4, the intra-regional analysis, consists of three parts. In Part 1, the examination proceeds by describing the character of foreign-owned research and development facilities sampled at the five locations. In particular, (1) facility missions, (2) their age, (3) their size and their growth rates, (4) the character of the knowledge work they conduct, (5) the nationality of their management, and (5) the size of their collaboration partner networks, are identified. In Part 2, the facilities' entry process is described in terms of (1) key and supporting factors in the facilities' location decisions, (2) their chosen entry mode, and (3) the initial size of the facilities. In Part 3, the integration process of the foreign-owned R&D facilities are examined. In particular, (1) the importance of different types of collaboration partners, (2) their distances to the location of the facilities, and (3) the networks that are used to activate interfaces to the regional innovation system, are examined. The aim of Section 4 is to identify regional patterns in the entry- and integration behavior of foreign-owned R&D facilities.

Section 5, the global analysis, combines all of the regional samples and searches for Pearson correlations between the quantitative variables within the research. The aim of Section 5 is to identify global patterns in the entry- and integration behavior of foreign-owned R&D facilities.

Section 6 combines the regional with the global analysis in two-step location-based cluster analyses of selected variables within the research to examine the validity and overlaps between the identified regional and global typologies. Section 6 demonstrates the great heterogeneity of foreign-owned R&D facilities world-wide, while at the same time delivering wide-ranging support for the models and typologies generated in the earlier sections of the work. A general conclusion summarizes the findings of the research and gives perspectives for future research.

Sections	**Part 1**	**Part 2**	**Part 3**
	Character of foreign-owned R&D facilities	Entry into regional innovation systems	Integration with regional innovation systems
	Mission, age, size today and growth, character of knowledge work, management nationality, size of partner network	Key investment drivers, supporting factors of location decision, entry mode choice and rational, size at founding	Types of collaboration partners, physical distance from partners, types of internal and external networks
4 - Regional description	✓	✓	✓
5 - Global correlations	✓	✓	✓
6 - Cluster analysis	✓	✓	✓

Table 1: Overview of the empirical study

1.13 Summary: theoretical introduction and gaps in the existing literature

Section 1 presents the theoretical foundation for the ensuing empirical study. Based on the fact that technological change is occurring at increasing speeds world-wide, company R&D functions are required to produce innovations faster, and to do so, need to be internationally present where they can gain access to leading knowledge resources. Their foreign R&D investments are directed at leading industry clusters world-wide. The internationalization of R&D is thus occurring mainly within the regions of North America, Western Europe, and Eastern Asia (with a few important exceptions such as India and Israel). These regions are leading in terms of technology and/or demand formulation. Being present in such a region enables companies to feed their transnational R&D networks' technology forecasting and demand forecasting systems with specific and locally bound knowledge. Regional innovation systems (RIS) present a possible framework to enable the systematic discussion of such lead regions. The RIS approach is thus adopted to describe the internationalization of R&D phenomena in this research. To become active with R&D in a foreign RIS, companies must enter into and integrate with the foreign innovation environment despite what is called liability of foreignness (LOF). LOF is a function of the compatibility between the corporate and regional innovation systems (CIS and RIS). This compatibility is in turn a function of the international absorptive capacities of the region and the investing company. Different entry modes, as described above, exist in order to respond to company and regional characteristics when a foreign-owned R&D facility is established. Even though numerous efforts have been undertaken in order to describe what makes regions attractive to FDI in R&D and much has been written about the location and entry mode decisions of companies' foreign subsidiaries, none of the existing works integrate the two views into a single research. The existing literature does not take on the micro-meets-macro approach taken on in this research. Furthermore, numerous studies profile single regions in terms of their characteristics for foreign-owned R&D. However, very few studies to date have proceeded to compare highly heterogeneous regional environments such as this study regarding the location, entry and integration behavior of foreign-owned R&D facilities.

Section 2: regional typologies

2.1 Conceptual model: generic building blocks for regional typologies

Regardless of any supposed homogenizing effects of globalization on regions and industries, RIS remain heterogeneous, and thus attract different types of foreign R&D. The following section discusses important specificities of five innovation systems in four countries: Beijing in China, London and Cambridge in England, Bavaria in Germany, and Stockholm in Sweden. Understanding the heterogeneity of regional innovation systems is an important step in trying to understand trends in the internationalization of R&D and the implications of entering into and integrating with different types of regional innovation systems.

The hypothesis in this section is that regional innovation systems around the globe vary considerably from one another, and that distinct typologies can be associated to different regions as a basis for an academic discussion of the foreign-owned R&D populations present there.

The individual subsections will show that while the regional innovation systems covered in this research differ considerably, they all consist of certain elements or 'building blocks' that enable the development of a regional innovation system typology. These elements are (1) the core or 'center of gravity' driving the innovation system (its 'raison d'être'), (2) the key organizations that generate knowledge and thus portray the supply side of the RIS, (3) the organizations that process and apply this knowledge and thus portray the demand side of the RIS, (4) the system's regional knowledge creation and innovation culture, and (5) the system's regional institutional environment. Both (4) and (5) have considerable influence on the mechanisms with which regional knowledge is generated and applied in the context of a globalizing economy. Finally, (6) there are the transfer factors that were already described above in the innovation terrain model. They are critical to enable the transfer of knowledge between the other five generic building blocks, enabling the novel assembly of existing knowledge and the dissipation of newly created knowledge to create technological change. Figure 8 below gives a schematic portrayal of the generic RIS typology that is the basis for the following regional typologies. The generic model of regional innovation systems is then applied to the five regions covered in this research.

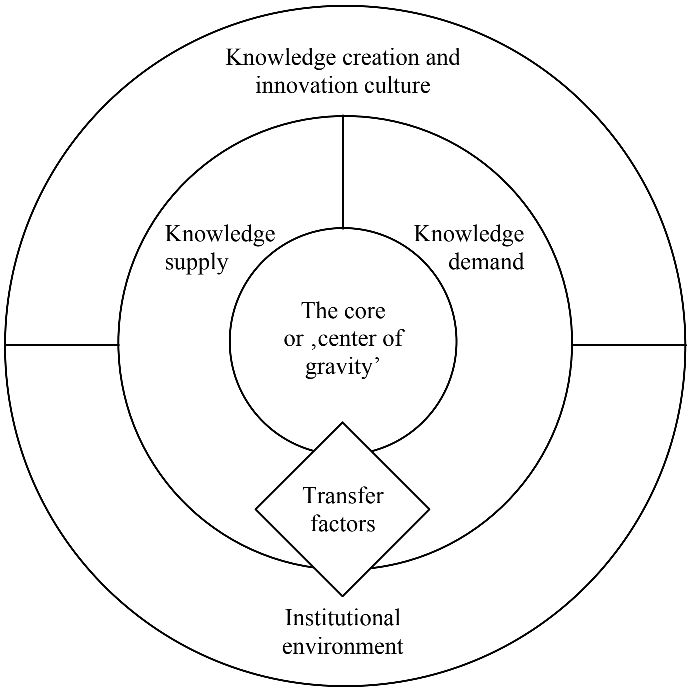


Figure 8: The six generic building blocks of regional innovation systems

2.2 Regional typology of Beijing, China: government-centric

In the context of the fast growing Chinese economy, I refer to the Beijing innovation system as the government-centric Emerging Giant. The regional innovation system's center of gravity is the Chinese central government. The government both defines and drives the Beijing innovation system and acts as the gatekeeper to the Chinese market of roughly 1.3 billion consumers. As a result of being China's political capital, Beijing furthermore hosts China's two leading state-owned universities Tsinghua University and Peking University. Consequently, China's best and brightest students and university researchers cluster in the Beijing area, which also hosts more than 150 other higher educational institutions, many more than any other Chinese city. Universities are thus the primary suppliers of knowledge to the Beijing innovation system. However, Chinese and international companies that are increasingly locating in Beijing are also contributing to the knowledge supply in the region, while at the same time acting the knowledge demand side. Knowledge processing and applying organizations (typically large Chinese companies with a state-owned history but now also increasingly high-tech MNC) cluster around the central government for access to regulatory bodies, and insight into government, government-owned enterprise technology spending schemes and government decision-makers. By doing so, they increase their chances of gaining access to China's vast market potential. Knowledge processing and applying organizations furthermore cluster around Beijing's leading universities to tap into the academic knowledge potential, to recruit excellent and inexpensive young talent, and to gain access to the extensive personal networks that leading university researchers have with government officials. In some cases, the cost advantage of outsourcing R&D to China are so attractive, that major Western corporations have given full global product mandates in R&D and manufacturing to Chinese subsidiaries.

The Beijing knowledge creation and innovation culture is characterized to a large extent by 'guanxi', the Chinese system of networking and personal relationship building, at the same time acting as the most important transfer factor in the Beijing innovation system. In this system, trust in collaboration partners builds slowly based on experience and reciprocity. Applied to the considerations of Uzzi (1997), Beijing thus has a high level of embeddedness of its economic actions. Knowledge creation and innovation networks evolve slowly and are difficult to gain access to. The culture of knowledge creation and innovation in the Beijing RIS is furthermore very much characterized by imitation of innovation and reverse engineering. For this reason, international technology is actively sought and international corporations are heavily encouraged to invest locally with R&D facilities. Paired with high levels of discipline and a highly hierarchic work culture, China aims to play catch-up with technology-leading nations by inviting them to develop technology in China to enable a transfer of these technologies to Chinese companies, universities, and other government institutions. Figure 9 gives a schematic indication of the government-centric typology attributed to the Beijing innovation system.

The high levels of institutional control exerted by the government over the generation and application of knowledge lends a bureaucratic dimension to the regional innovation system. However, once decisions are taken, the business implications are vast, given the government's aim to modernize the Chinese economy at unprecedented speeds. The specific nature of Beijing's knowledge creation and innovation culture as well as its transfer factors make it a region of potentially high levels of LOF for foreign investors.

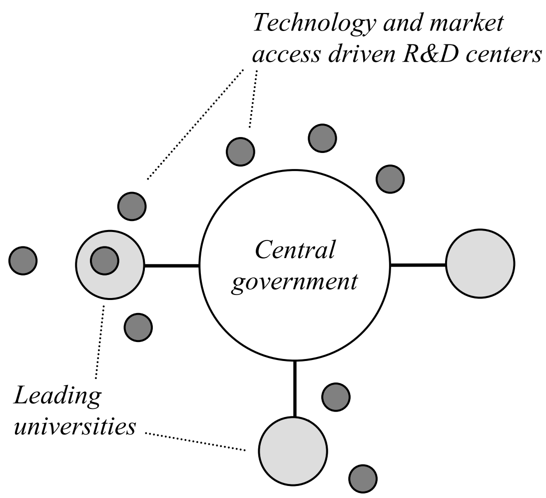


Figure 9: The government-centric Beijing innovation system

The central government as the core of the innovation system is portrayed at the center, with strong links to the leading universities located in Beijing. Foreign-owned R&D facilities in Beijing are represented by the smaller, darker circles, seeking proximity to the government as well as the universities, or even locating within university premises (so called embedded R&D facilities). Foreign-owned R&D facilities here conduct both technology pull and market push, but with a focus on market access and home-base exploiting R&D. As opposed to Shanghai, which is considered the more market driven of the two urban centers, facilities here benefit specifically from immediate access to political gate-keepers and top graduates.

2.3 Regional typology of London, England: urban-centric

In the context of England's traditional bridging function between the US and Europe, the greater London innovation system is referred to as the urban-centric Gateway to Europe. The system's center of gravity is the urban center of London with its international airports and its relative proximity to continental Europe's 300 million and growing consumer market. Due to its geographic location, its business friendly environment, and the fact that English is spoken, greater London has established itself as a point of entry for non-European companies wishing to access Europe. With time, the greater London innovation system (referred to hereafter as the London innovation system), supported by the infrastructure of the urban center and a high quality of life, has built critical mass. As globalization accelerated towards the fourth quarter of the 20th century, R&D facilities were often added to existing foreign-owned sales and marketing or manufacturing organizations. An RIS with a great level of heterogeneity as an R&D region, knowledge within the greater London innovation system is mainly generated, processed and applied (covering both the supply and the demand sides) – with the support of universities – by the employees of an industrially and internationally diverse population of technology-intensive companies. These companies are located throughout greater London while they cluster to the west and south west along the M4 and M3 corridors.

The innovation environment in the London innovation system can be described as internationally open and collaborative, promoting multi-national and multi-disciplinary innovation projects, an entrepreneurial stance towards technological change, and active knowledge generating inter-firm job-rotation. Both the knowledge supply and the knowledge demand sides here are thus very much driven by large private enterprises. Except for its efforts to remove barriers to knowledge creation and innovation, the influence of the institutional environment on the regional innovation system is minimal. According to local actors, the government should not and does not play an active role in the greater London innovation system.

Transfer factors include frequent job rotations, increasing industry-university collaborations, and a large number of private initiative industrial networking organizations. Again the state does not play much of a role as a transfer factor, even if EU framework programs and the U.K. Department of Trade and Industry are frequently mentioned when transfer factors are discussed within the London innovation system. Figure 10 gives a schematic indication of the urban-centric typology attributed to the London innovation system.

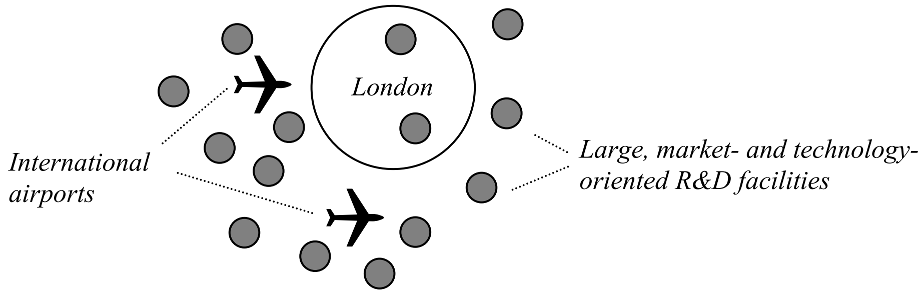


Figure 10: The urban-centric London innovation system

Figure 10 indicates the urban center as the core of the London innovation system, driven mainly by historically achieved critical mass as an access point to Continental Europe, good travel infrastructure (indicated by the two international airports), and the quality of life of the greater London area. Universities play less of a role as partners in research here, but more of a role as partners for the recruitment of R&D employees. Foreign-owned R&D facilities originally located here mainly to establish an R&D presence in proximity to Europe and with direct access to the US and Asia. As a consequence, the heterogeneity of the foreign-owned R&D population is vast, with both market- and technology-driven foreign facilities.

2.4 Regional typology of Cambridge, England: university-centric

Given the small size of Cambridge and the limited infrastructure of the city's surroundings, the Cambridge innovation system is referred to as the university-centric Small is Beautiful location (see also: Saperstein and Rouach, 2001). The system's center of gravity is the University of Cambridge. The University enabled the initial formation of the Cambridge innovation system, while acting as the driving supplier of knowledge to the region even today. The greater Cambridge area hosts a large number of academic and industrial research organizations, UK- and foreign-owned alike. The companies that have located in proximity to the University to partake in the innovation system mainly conduct research as opposed to development activities. Numerous large companies have placed small corporate research laboratories within (embedded laboratories) and around University premises. Companies are furthermore attracted to Cambridge as a location for R&D due to the many high-technology companies originally founded by Cambridge academics that were eventually spun out from University institutes and now have offices in the Cambridge area, making up the demand side of the knowledge equation in this RIS. Substantial clustering occurred here regardless of the limited availability of international flight connections and the rather long driving distance of more than 1.5 hours to the urban center of London.

According to local actors, Cambridge is a small, quiet, and science-driven place. Local industrial R&D facilities, often managed by former University professors, entertain close links with university institutes. The innovation environment is thus one of academic freedom of thought and criticism, trial and error, and a fascination for science. For this reason, Cambridge companies tend to stay small. Research is considered more important than marketing, scientific excellence more important than growth. Rather than growing large by their own effort, Cambridge technology companies are typically acquired by larger, international players.

The institutional environment is one of very little government intervention. According to local actors, there is a historic contempt for government involvement in science and technology. Consequently, the Cambridge innovation system is characterized by private, individual initiative and private organizations. The most important transfer factors here are personal networks that originate from the University. Several networking institutions such as the Cambridge University Entrepreneurship Centre, the University Corporate Liaison Office and the Cambridge Network are of importance but are less important than direct personal links. Figure 11 gives a schematic indication of the university-centric typology attributed to the Cambridge innovation system.

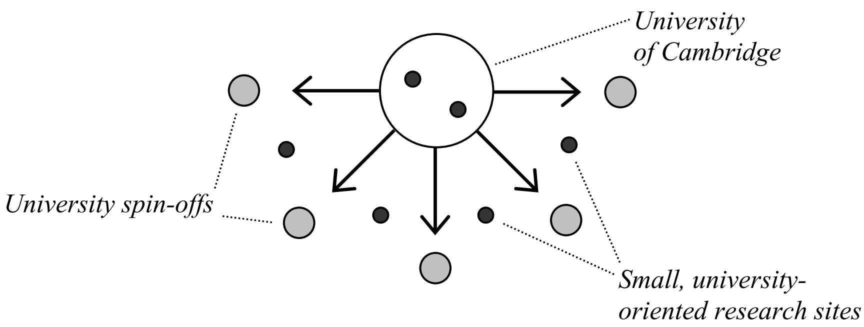


Figure 11: The university-centric Cambridge innovation system

Figure 11 shows the University as the center of the Cambridge innovation system, with arrows indicating the university spin-outs that make up a large share of the small and medium sized technology companies in the Cambridge area today. Foreign-owned R&D facilities cluster here to benefit in the widest sense from the knowledge generated in the University, as well as in the spin-out companies – many of which have already been acquired by larger technology companies.

2.5 Regional typology of Stockholm, Sweden: key company-centric

The Stockholm innovation system is referred to as the key company centric Niche Leader, referring to the world-leading communications cluster that has formed over the years throughout the greater Stockholm area. In this cluster, the company Ericsson was and still is a key defining and driving force. Sweden has been a leader in telecommunications technology since long before the telecoms boom of the late 20th century and Ericsson has been a key industrial contributor in this context. Large numbers of Swedish technology SME began as Ericsson spin-outs. Special regional competencies evolved not only in the field of telecoms and mobile telecoms, but also in the field of mobile computing as computing companies were attracted to the originally telecoms-driven Stockholm innovation system. Growing global demand for mobile knowledge management tools added another knowledge component to the Stockholm innovation system. Companies conducting R&D in the Stockholm area and thus constituting the demand side of the knowledge equation in this RIS thus originally sought proximity to Ericsson and Ericsson spin-out companies, presenting the RIS with knowledge supply, be it to drive their own telecommunications solutions, or to drive the convergence that was occurring here between computing, telecommunications, and other technologies. However, the Stockholm innovation system has proven volatile. Whereas foreign-owned R&D centers here in the late 1990s until about 2001 conducted technology scanning activities at the intersections of emerging technologies, the R&D activities identified in the context of this research in early 2004 were mostly limited to small-scale development, design and customer service-driven R&D. For the sake of the regional typology, both types of R&D a schematically presented below.

The innovation environment in the Stockholm system is known to be collaborative, team driven, and internationally open. Sweden, with approximately eight million inhabitants, is a small country. Within industrial networks, people know each other and have links to important academic and industrial organizations. Due to Swedish work culture, hierarchies are flat, promoting individual initiative and teamwork. Due to the fact that Sweden has always been an export-driven economy, Swedes' English skills are excellent and the environment is internationally open.

The institutional environment, characterized by many years of socialistic policies, has at the same time been characterized as politically entrepreneurial and pro-technology by encouraging technology adoption by the Swedish people and their administration, and by producing generally technology friendly policies. Technology in Sweden was even seen by the conservative government in 2001 to be a tool to close the gap between rich and poor (Saperstein and Rouach, 2002), a tool enabling Swedes in remote parts of the country to access education, trade, and other fields typically reserved for those living in metropolitan centers.

Transfer factors for a large part are the personal networks that exist due to the fact that Sweden is a relatively small nation with few leading universities in-between which industrial and academic leaders all know each other. Furthermore, the fact that the innovation system's history is so closely tied to the company Ericsson indicates that may leaders will at one point in time have worked at Ericsson and will have strong Ericsson-based personal networks from this time. Figure 12 gives a schematic indication of the key company-centric typology attributed to the Stockholm innovation system.

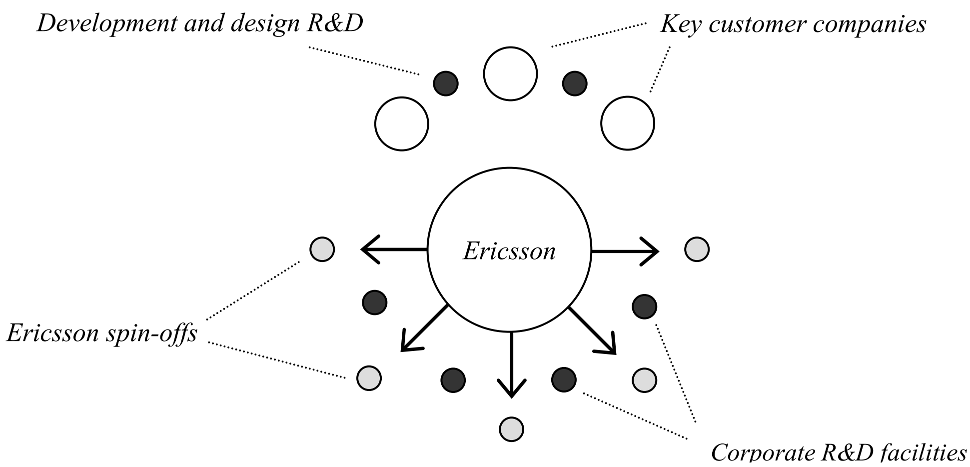


Figure 12: The key company-centric Stockholm innovation system

Figure 12 shows Ericsson as the core of the Stockholm innovation system, originally attracting foreign corporate R&D facilities due to its pioneering positions in many telecoms-related fields. In addition, due to the volatility identified in the RIS over the past years, large key customer companies are indicated that were important factors in the recent attraction of foreign development and design related R&D activities. The fact that spin-out companies played an important role in the formation of the RIS gives resemblance to the Cambridge system, only that here, an academic institution rather than a large lighthouse company was their origin.

2.6 Regional typology of Munich, Germany: triple helix-centric

Since the Munich RIS has the least clearly distinguishable regional typology of the five regions covered, I refer to the greater Munich innovation system as triple helix-centric Established Diversity. The center of gravity in this system is difficult to define. It consists in principle of numerous elements including the global headquarters of Siemens, BMW, and MAN, the key presences of the three leading German state research organizations Max Planck, Helmholtz, and Fraunhofer, the presence of the reputable Technical University of Munich, and the generally business friendly Bavarian state government. The Munich innovation system thus corresponds with a model commonly referred to as the triple helix. Each of the elements of this triple helix (industry, academics, government) have their roots in the years following World War II. Before the War, Bavaria was mostly an agrarian state. Due to the Soviet occupation of Eastern Germany after the War, Siemens decided to move its headquarters, until then divided between Munich and Berlin, to Munich. A few years later, Max Planck Gesellschaft and Frauenhofer Gesellschaft decided to move important parts of their organizations to Munich as well. The decision to turn Bavaria into Germany's high-tech capital however, was made by the Bavarian Minister President Franz Joseph Strauß, whose vision today is accredited with much of Bavaria's wealth and its position as Germany's leading technology location.

The organizations generating knowledge in the Munich innovation system today are lead companies such as Siemens, numerous state-research organizations, and Munich's Technical University. The combined presence of each of them has caused many technology companies to locate headquarters or R&D groups in the greater Munich region, portraying the demand side of the knowledge equation in this RIS, while Munich also has the greatest density of high-tech start-ups in all of Germany. For instance, Martinsried, located on the outskirts of Munich, is considered a European hotspot for bio-tech start-ups.

The innovation culture in Munich is one of precision and technological excellence. However, the entrepreneurship culture apparent in Munich has not yet produced any global players in high-technology sectors. It is thus assumed that the innovation culture in Munich is technology- rather than growth-driven, and that the commercialization competence required for technology transfer, company formation and company growth remain rather limited.

The institutional involvement in the Munich innovation system is of key importance. State-owned venture capital funds, state subsidies to large technology companies and high-tech initiatives, and aggressive marketing of the Bavarian business environment to foreign investors play a key factor in the success of Munich's innovation system. Key transfer factors are personal professional networks gained while working for Munich's lighthouse companies (i.e. Siemens) and Universities (Technical University of Munich and LMU). However, many network initiatives that were conceived during the economic boom of the late 1990's have been closed down due to industry's lack of interest to pay for the network services. Organizations such as the Japan Economic Trade Organization (JETRO) exist in Munich as in the other innovation systems portrayed in this research, but their net effect on knowledge creation and innovation in the region is unclear. Thus, job rotation (which is slower here than in the UK) and the large amount of qualified graduates from Munich's two large universities are the most important transfer factors. Figure 13 gives a schematic indication of the triple helix-centric typology attributed to the Munich innovation system.

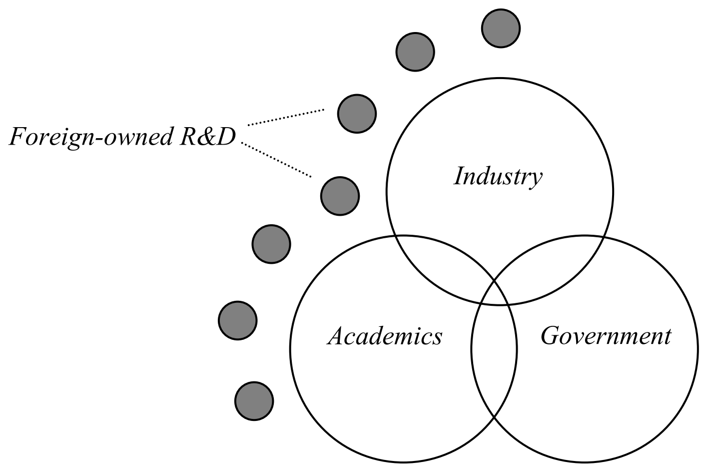


Figure 13: The triple helix-centric Munich innovation system

Figure 13 indicates a triple-helix in which industry, academics, and government work together, each component supporting the other two. Even if the symbiosis between the three elements may not work any better in Munich than in the other regions profiled in this work, Munich nonetheless has excellent preconditions for a working triple helix due to the critical mass and high levels of quality regarding technology competence it has in each of the three fields. Foreign-owned R&D facilities locate in Munich to benefit from either one of the triple helix factors or a combination of them. The population of foreign facilities in Munich is thus highly heterogeneous, similar to the population of the London innovation system.

2.7 Summary: regional typologies and how they compare

The above typologies are not perfect or exhaustive, nor are they to be associated exclusively with the specific regions as presented above. Due to the complexity and diversity of each of the five regional innovation systems, each one of them in reality will contain certain elements of each of the typologies. However, the association of particular typologies with specific regions shows that RIS can differ substantially from one another and can thus be expected to host substantially differing populations of foreign-owned R&D.

Once again, the typologies presented above are (1) Beijing – the government-centric system, (2) London – the urban-centric system, (3) Cambridge – the university-centric system, (4) Stockholm – the key company-centric system, and (5) Munich – the triple helix-centric system. Each of the systems was briefly characterized in terms of the elements that define and drive the system, the elements that generate, process, and apply knowledge in the system, the system's innovation environment, and its institutional environment. Below, Table 2 gives an overview of the key findings.

	Reference	**Center of gravity**	**Knowledge supply**	**Foreign knowledge demand**	**Innovation culture**	**Institutional environment**	**Transfer factors**
Beijing, China	Emerging giant	Chinese central government	Top two universities	Market access & cost driven facilities	Guanxi, reciprocity	Government is gate keeper	Guanxi, job rotation low employee loyalty
London, England	Gateway to Europe	Urban center of London	Technology companies	Large R&D sites seeking EU presence	Internat'l openness	Hardly any involvement	Job rotation, industry-univ. collaborations
Cambridge, England	Small is beautiful	University of Cambridge	Cambridge University	Smaller, research driven facilities	Fascination for science	Hardly any involvement	Personal univ. based networks
Stockholm, Sweden	Niche leader	Ericsson and its spin-out companies	Lighthouse company	Key customer and telecom related sites	Team-driven	Political entre-preneurship	Personal netw. and Ericsson networks
Munich, Germany	Established diversity	Industry, academics, gov'mt	Companies, univ. & state R.	Market and compe-tence seeking R&D	Precision, excellence	Government is key player	Increased ind-univ collab. Networks lose ground

Table 2: Overview of regional typologies and their key components

The findings confirm one of the original hypotheses that lead to the implementation of this research: Regional innovation systems around the globe vary considerably from one another, and distinct typologies can be associated to different regions as a basis for an academic discussion of the foreign-owned R&D populations present there. Further research should aim to identify more regions that fit the five typologies to examine whether they have global validity in cases other than those presented here.

Before the foreign-owned R&D facilities located within each of the five regional systems are examined in greater detail, the first part of Section 3 presents the variables and classifications used to conduct the ensuing intra-regional analysis, as well as the MMB model which is used to describe different types of foreign-owned R&D facility types in the context of the different regional settings.

Section 3: variables and facility-driven model

3.1 Presentation of variables

3.1.1 Characteristics – R&D mission

R&D missions vary among other things in terms of their orientation towards research and/or development. Possible respondent answers to the question of their facility's R&D mission were: 100% development, 75% development – 25% research, 50% development – 50% research, 25% development – 75% research, or 100% research. A classification for the intra-regional analyses leads to three R&D mission categories: (1) pure play development facilities, (2) dual research and development facilities, and (3) pure play research facilities. Each of the categories are present in each of the five regions with specific regional contexts. These contexts are referred to in detail further below. For the two-step cluster analyses that follow the intra-regional analyses, facilities in the 100% and 75% development categories are considered 'development facilities', facilities in 100% and 75% research categories are considered 'research facilities', and facilities in the 50% research – 50% development category are considered 'R&D facilities'.

3.1.2 Characteristics – facility age

This variable refers to the facilities' age in 2004. The founding year refers to the year of founding in the case of greenfield investments and other 'make' entry modes, while referring to the year of acquisition in the case of acquisition or 'buy' entry modes. A classification of facility ages was conducted in the global analyses as follows: (1) 0-5 years, (2) 6-10 years, (3) 11-15 years, and (4) 16 years and older. Category 1 indicates facilities that were founded at a time when the Internet and mobile telecommunications had established themselves as mass-usage technologies, and bio-technology increasingly revolutionized pharmaceutical sectors. Categories 2 and 3 indicates facilities that were founded at a time when communications technologies were experiencing strong growth and when bio-technologies began to proliferate, becoming an increasing issue in ethical commissions around the world. Category 4 indicates facilities that were founded before the surge in technology growth experienced during the 1990s and the R&D internationalization wave that followed. These facilities can be considered to have been founded mainly to have an R&D presence in major markets outside of companies' home markets as foreign development centers with technology scanning offices. In many cases, these facilities came to be through acquisitions, where production and sales structures were acquired along with R&D capacities.

3.1.3 Characteristics – facility size in 2004

This variable refers to the number of scientific and engineering staff employed by the R&D facilities at the time of the empirical study in the first half of 2004. Size potentially has considerable implications on a foreign-owned facility's integration with the foreign region: according to the imperative of reciprocity (Zedtwitz and Heimann, 2005), knowledge exchange transactions that are often difficult to evaluate in monetary terms, instead are conducted on the basis of reciprocity. This implies that for knowledge-based interaction to take place between knowledge carriers of the RIS and the CIS, reciprocal benefits must be given. Greater facility size has a potentially beneficial effect on regional integration, because large and growing facilities are seen by knowledge carriers in the RIS to have a greater potential to contribute knowledge than small technology scanning offices with an interest only in picking up knowledge, but not in sharing knowledge.

A classification for the global analyses was conducted as follows (numbers indicate amount of R&D personnel): (1) 1-10, (2) 11-30, (3) 31-60, (4) 61-100, and (5) 100 or more. Those in category 1 are referred to as 'small sized R&D facilities', typically with specific and narrowly defined areas of responsibility, either reporting directly to the mother company's board of management, or working closely with local manufacturing units or key customers. Those in categories 2 and 3 are referred to as 'medium sized R&D facilities', typically with wider areas of responsibility including regional responsibilities such as product mandates for particular geographic markets. Those in category 4 and 5 are referred to as 'large sized R&D facilities', potentially holding global product mandates while working closely with large scale manufacturing groups inside the company.

3.1.4 Characteristics – facility growth

This variable measured the growth of scientific and engineering staff in the facilities per annum since the founding year. A classification for the global analyses was conducted as follows: (1) Zero: no increase in staff since founding, (2) Slow: 1-5 staff growth p.a., (3) Medium: 6-11 staff growth p.a., (4) Fast: 12 or more staff growth p.a., (5) Negative: less staff in 2004 than in year of founding. The data reveals that facilities starting out large also had greater growth rates. Facility growth, as indicated above, demonstrates commitment to the RIS. Therefore, according to the imperative of reciprocity, small but fast growing facilities willing to enter into exchange with the local knowledge carriers, as long as they communicate this growth to the RIS, may find it easier to integrate than small facilities with slower or no growth. However, this consideration is highly theoretical. In practice, facilities establish networks of collaboration partners interested in content, not the facility's rate of growth. The growth argument on the other hand can be expected to play a more important role in cases where regional authorities will assist a facility's regional integration depending on its commitment to the region. Especially regions with an interest in the sustainability of regional R&D investments will be interested in medium term growth plans of foreign-owned facilities.

3.1.5 Characteristics – manager nationality

This variable established whether the leaders of the facilities were of the nationality of the parent company, the nationality of the host country (the location of the foreign facility), or none/both of the two. A classification of manager nationalities for the global analyses was conducted as follows: (1) home country national, (2) none/both of the two, and (3) host country national. The logic behind this categorization lies in the trade-off between parent company integration and local regional integration, as indicated in Figure 14 below. In the model, the level of integration with the target region is highest when host country nationals lead the facility, while the level of integration with the parent company (and thus the level of control that can be exerted by the parent company) is maximal when home country nationals lead the facility. Intermediate solutions are possible when Category 2 nationalities are chosen for the facility leadership.

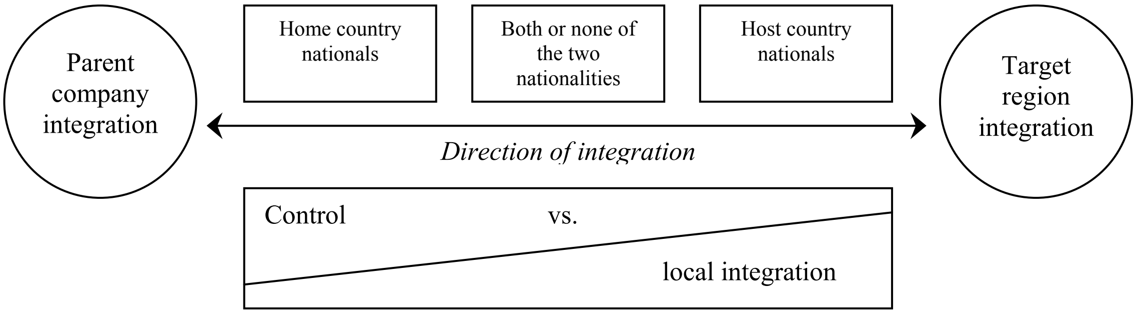


Figure 14: R&D manager nationality as an interface to the RIS and the parent company

Even if this categorization may seem sensible at first sight, care must be taken to differentiate when host country nationals with long employment records with the parent company in the home or the host country take over the management of the foreign R&D facility. In this case, parent company and target region integration may be given regardless of nationality. This issue is touched upon again further below.

3.1.6 Characteristics – size of collaboration partner networks

External collaboration partner networks are divided into two variables: (1) number of key collaboration partners and (2) number of other collaboration partners. Key collaboration partners are those with whom long term, formalized partnerships are conducted, whereas other collaboration partners are those with whom short, possibly ad hoc, and informal collaborations are conducted. A classification of the different collaboration partner network sizes was conducted in the global analyses as follows (numbers indicate amount of partners): For key collaboration partners: (1) 0-5, (2) 6-10, (3) 11-20, (4) 21-30, and (5) 30 and more. For other collaboration partners: (1) 0-10, (2) 11-20, (3) 21-30, (4) 31-40, and (5) 41 and more. Category 1 indicates small networks, Categories 2 and 3 indicate medium sized networks, while Categories 4 and 5 indicate large networks. Whereas smaller network sizes may be associated with facilities that build more on internal resources, larger network sizes may be associated with facilities that leverage their foreign presence by internalizing external knowledge resources. It was originally assumed that smaller facilities with less resources will therefore have larger key and other partner networks, whereas larger facilities with internal resources will try to protect against the dissipation of proprietary knowledge by limiting the sizes of their partner networks. However, the empirical data, as indicated below, does not show support for such a hypothesis. Instead, network sizes seem consistent independent of region or facility size.

The ratio between other and key partner network sizes gives insight into whether partnership networks are networks of depth and/or networks of breadth. In certain cases, 'other' networks may even be smaller than 'key' networks. Gaining insight into the partnering behavior of foreign R&D facilities is of importance to understand the partnering activity actually going on in supposedly 'collaborative' regions, as well as to understand foreign facilities' needs when they enter into such a foreign region. Original hypotheses that partner networks go through a transition from breadth to depth with time could not be verified based on the empirical data. Instead, the key/other ratio was consistent regardless of region or age of the facility.

3.1.7 Characteristics – character of the knowledge work

The character of the R&D conducted at the facilities was examined by measuring whether facilities follow (1) explorative or exploitative aims, (2) collaborative vs. proprietary aims, and whether they are (3) tacit or explicit knowledge driven. As indicated in Table 3, respondents were asked to position their facilities' knowledge work within these dimensions.

	100/0	**80/20**	**60/40**	**40/60**	**20/80**	**0/100**	
Explorative aim							Exploitative aim
Collaborative aim							Proprietary aim
Tacit knowledge							Explicit knowledge

Table 3: The character of knowledge work in foreign-owned R&D facilities

Based on the literature covering research and development and knowledge management, two clusters of facilities were originally expected to emerge from the sample: (1) the explorative, collaborative, tacit cluster, and (2) the exploitative, proprietary, explicit cluster. The categorization of facilities into these clusters was expected to depend heavily on some of the other variables already discussed in this section. The explorative versus exploitative dimension was expected to correlate with R&D mission, the collaborative versus proprietary dimension was expected to correlate with the data on collaboration partner network sizes, while the tacit versus explicit dimension was expected to correlate with the physical distance from collaboration partners (to be discussed below): tacit knowledge necessitates physical proximity, explicit knowledge enables physical distance. The purpose of examining these dimensions was to allow for an interpretation of the values given to the variables R&D mission, R&D collaboration partner network size, and distance to collaboration partners, for instance to answer the question: do large partner networks really indicate that facilities follow collaborative aims with the intent to internalize external knowledge? The data shows that such clustering hardly occurs in the tacit/explicit dimension, while it occurs more strongly in the collaborative/proprietary dimension. As supposed, there is a strong correlation between R&D mission and the explorative/exploitative dimension.

3.1.8 Entry – key drivers of the location decision

Key drivers of the location decision were introduced as variables after pre-study interviews indicated that all foreign R&D facilities follow a maximum of one to two key objectives when selecting a region as their location, possibly supported by a host of other factors (referred to as supporting factors). In numerous cases, key drivers of the location decision in fact pre-determined an actual location decision: if an acquisition was conducted, the R&D investment decision was most often based on the acquisition candidate, not on this candidate's physical location. In such a case, any other supposed factors of the location decision can be seen merely as supporting factors.

Therefore, many foreign R&D investments can be expected not to have gone through much of a location decision at all. To gain insight into which were the driving factors behind the R&D investments, and how much of a location decision a foreign investment actually implied, the factors presented in Table 4 were rated from 0 to 4 by respondents based on their importance in the investment decision (0: not important at all, 4: of critical importance).

		0	1	2	3	4
1	A single scientist in the foreign region					
2	A university institute in the foreign region					
3	A company to be acquired in the foreign region					
4	A company to collaborate with in the foreign region					
5	The leading foreign technology region					
6	The important foreign market potential					
7	Attractive local labor market					

Table 4: Key factors in the R&D investment location decision

3.1.9 Entry – supporting factors in the location decision

Once the key drivers of the R&D investment decision are established, additional factors can be identified supporting the attractiveness of the location for the work of the foreign R&D facility. These can be identical to those already cited as key drivers but need not be. The factors were ranked by respondents in their importance from 0 to 4 as supporting factors in the local investment, as indicated in Table 5 below.

		0	1	2	3	4
1	Proximity to large target/lead market					
2	Proximity to strong target/lead market growth					
3	Proximity to strong university research					
4	Proximity to strong state research					
5	Proximity to large scientific labor pool					
6	Presence of key customer companies					
7	Presence of key suppliers/vendor companies					
8	Presence of key complementary technology companies					
9	Presence of key competitor companies					
10	Highly conductive research and innovation environment					
11	Favorable government and administrative environment					
12	Favorable public transport infrastructure (i.e. airports, highways, etc.)					
13	Strong local presence of Parent Company					
14	Strong local presence of other companies from the home country					
15	Strong local presence of other international companies					
16	Strong local experience of the Lab Manager					
17	Cultural proximity to the home country					
18	Government financial incentives					
19	Regional marketing and relocation services					

Table 5: Supporting factors in the R&D investment location decision

The data indicating key and supporting investment location decision drivers correlates closely with the five regional typologies presented in Section 2, both in terms of key location drivers relating closely with the core or center of gravity of the regional typologies, and the supporting factors relating to the elements of knowledge supply and demand, as well as innovation culture and administrative environment.

3.1.10 Entry – character of the location decision

Location decisions, as indicated above, can be intuitive due for instance to the acquisition of a company that happens to be based at a certain location. Location decisions however, can furthermore be emotional, when designated facility managers chose a location due to a personal affinity to the place. Though this situation does not represent the majority of cases, several managers indicated this to be the case. Location decisions can, and often are, lengthy, analytical processes. When the decision is to build a presence in Europe, for instance, then the parent company may consider buying a company in the UK, Germany, or France. In such a case, the location decision comes first, the entry mode decision comes second. As originally expected, most respondents indicated location decisions with analytical as well as intuitive elements. Most decisions however, were more analytical, than intuitive. This can be explained by the fact that most entry modes in the sample were greenfield investments, so that locations were not predetermined by the location of acquisition targets or collaboration partners. Figure 15 below, shows the possible values attributed to this variable.

- ☐ Strictly lengthy/analytical
- ☐ More lengthy/analytical than intuitive/emotional
- ☐ More intuitive/emotional than lengthy/analytical
- ☐ Strictly intuitive/emotional

Figure 15: The character of the foreign R&D investment location decision

3.1.11 Entry – entry mode choice

As indicated in the theoretical introduction on entry modes in Section 1, the entry modes encountered in this research are greenfield investments, add-on investments, acquisitions, joint ventures, and university spin-ins. As was the case with the location decisions above, entry mode decisions can be predetermined by factors unrelated to the entry mode decision. For instance, if a company wishes to place an R&D facility in a certain region, acquisition entry will only be possible if there is a population of suited acquisition candidates present locally. This may be much more so the case in Cambridge, which hosts many Cambridge University spin-out companies, than in Beijing, where local companies lag far behind Western companies in terms of their technological capabilities and thus may not be suited as acquisition candidates. Thus, entry mode decisions, as they are referred to in the literature, when conducting a global study such as this one, may emerge to be much more necessity-driven than virtue-driven. The necessity-character of entry mode decisions is confirmed by the data, which does not indicate a correlation between R&D mission or other facility-specific characteristics and entry mode, but instead indicates regional specificities such as indicated above in this paragraph.

3.1.12 Entry – facility size at entry

The facility size at entry variable complements the facility size in 2004 variable. Knowledge of how large, in terms of R&D staff, the facilities were in their year of founding enables insight into the level of financial commitment made to the location in the founding year. This commitment gives insight into the parent company's perceived level of risk associated with conducting R&D in the given region and, when paired with the growth variable, gives insight into how satisfied the parent company has been with the regional investment. A classification of the variable for the global analyses is conducted as follows (numbers indicate amount of R&D personnel): (1) 0-9, (2) 10-29, (3) 30-59, (4) 60-99, (5) 100 or more. While Category 1 is referred to as 'small size at founding', Categories 2 and 3 are referred to as 'medium size at founding'. Categories 4 and 5 are referred to as 'large size at founding'. The data reveals that the size at founding variable furthermore correlates with R&D mission and entry mode.

3.1.13 Integration – collaboration partners

In the compatibility model, external collaboration partners were described as interfaces to the RIS. Respondents were asked to indicate the importance of different external collaboration partner types for actual ongoing collaborations. Thus, this question did not relate to factors influencing the location decision, but aimed instead to find out which collaboration partners are used post-entry to integrate with the RIS. The collaboration partner types, as indicated in Table 6, cover both horizontal and vertical industry collaborations, including key customer companies, supplier/vendor companies, complementary technology companies, competitor companies, as well as the research-driven partner types universities, and state research labs (non-university). The original hypothesis was that the collaboration partner types used in different RIS around the world would vary as a function of the regional typology associated with the location of the foreign-owned R&D facility.

		0	1	2	3	4
1	Universities					
2	State research labs					
3	Key customer companies					
4	Supplier/vendor companies					
5	Complementary technology companies					
6	Competitor companies					

Table 6: Collaboration partners as interfaces to the RIS

The data shows broad support for the hypothesis, indicating that both the core or center of gravity, as well as the knowledge supplying and knowledge demanding actors in the different regional typologies are used as collaboration partners to integrate with the respective RIS.

3.1.14 Integration – physical distance from collaboration partners

To find out whether physical proximity mattered to the above collaborations and to which extent it mattered, respondents were asked to indicate how far away from their facilities the collaboration partners identified above were located. For this purpose, radiuses were given and then ranked in their importance. Respondents were asked to conduct this ranking based on how many collaboration partners were located within each of the radiuses (see Figure 16). The radiuses were (1) less than 0.5 hour driving distance, (2) 0.5-2 hour driving distance, (3) more than 2 hour driving distance within the host country, and finally (4) outside the host country.

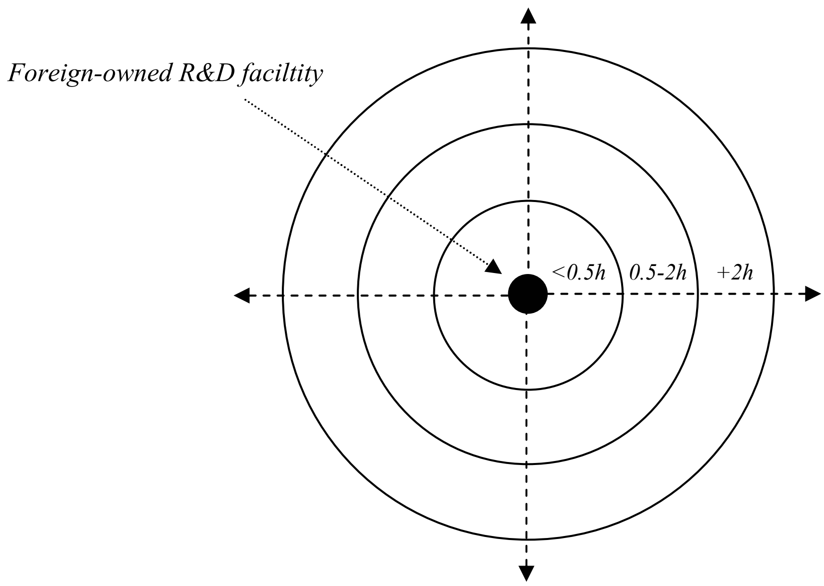


Figure 16: Examining the physical proximity to collaboration partners

The data indicates that physical proximity played an important role at some locations, while playing less important roles in other locations. In numerous cases, the physical proximity of collaboration partners seems irrelevant. In numerous other cases two radiuses play equally important roles: the very proximate radius, and the very distant radius. Further discussion of this issue may have an impact on future cluster policies as well as the R&D location decisions of MNC.

3.1.15 Integration – networks used to activate interfaces to the RIS

Three categories of networks were examined to gain insight into how the interfaces to the regional innovation systems were activated by the foreign-owned facilities: (1) internal networks, (2) external third party networks, and (3) external networking platforms. Different networking behavior of foreign-owned R&D facilities was expected as a function of location and R&D mission, since (1) different regional typologies with different centers of gravity imply different interfaces to the regional innovation system, and (2) different R&D missions imply different regional integration needs, implying the use of different interfaces and thus different networks in order to aid their activation. Table 7 lists the three network types below.

	Network	Type
1	Facility Manager's personal network	Internal
2	Facility scientists' personal networks	Internal
3	Facility human resources (HR) department	Internal
4	Facility public relations (PR) department	Internal
5	Home country managers’ personal networks	Internal
6	Host country non-R&D mangers' personal networks	Internal
7	External consultants	Third party
8	Government matchmaking networks	Third party
9	Headhunters	Third party
10	PR Firms	Third party
11	Advertising agencies	Third party
12	Industrial clubs	Networking platforms
13	Non-industrial clubs	Networking platforms
14	Open industrial networks	Networking platforms
15	Open non-industrial networks	Networking platforms

Table 7: Internal networks, external third party networks, and external networking platforms

While the importance of R&D managers’ and R&D employees’ personal networks are trivial, facility human resources (HR) departments potentially play an important role in the process of recruiting knowledge from the RIS. Facility public relations (PR) departments may play an important role in communicating the presence and the activities of the foreign facility in the RIS, thus possibly laying the foundation for future knowledge collaborations. Home country managers may play an important role as initial door openers to high level company and administrative contacts in the region, whereas host country non-R&D managers may do the same, possibly at a somewhat lower level. External consultants may make their local contacts available to the facility, and may act as pilots navigating through the RIS, thus facilitating regional integration. The same service could also be provided by government matchmaking initiatives. External headhunters, advertising agencies, and PR firms could support the facilities’ own HR and PR initiatives. Industrial clubs are defined as membership-driven industry networks offering network-related benefits to their members. Non-industrial clubs are defined as membership-driven scientific and other non-industrial networks. Open industrial networks are defined as open to anyone willing to participate, as are open non-industrial (principally scientific) networks. The prime difference between the club and the open networking platforms is that on-going membership requires a longer term commitment (time-wise and financially) whereas open networks are more ad hoc and spontaneous in their integration facilitation role.

The data shows that by far the greatest importance is attributed to R&D manager and R&D employee networks, followed by industrial and non-industrial networks. The other networks are relevant at certain locations, but on average play much less important roles.

3.2 Conceptual model: mission-motive-behavior (MMB)

3.2.1 Introduction

The model aims to associate different types of foreign-owned R&D facilities with the different regional typologies of RIS, and to enable a discussion of the role they play in within these regional environments. To establish types of foreign-owned R&D, facilities are characterized by describing (1) their R&D mission (research versus development), (2) their motive for locating in a specific region (market-driven, science- and technology-driven, cost-driven), and (3) their integration behavior when aiming to access regional knowledge resources (network-based behavior versus independent firm based behavior). A simple schematic overview of the model and its dimensions is given in Figures 17 and 18 below.

3.2.2 Mission

As indicted above, R&D missions can imply pure-play research, pure-play development, or joint R&D. Facilities seek locations in part as a function of their R&D mission. In addition to respondents' indications of R&D mission, information on the character of the facilities' knowledge work (exploitative/explorative, tacit/explicit) gives further indications on facility mission. Reference is taken at this point to Kümmerle (1998) and the HBE/HBA augmenting model. Lead regions such as those examined in this research may provide an environment for diverse types of R&D missions, so that different mission-types can be expected in each of the five regions.

3.2.3 Motive

Foreign R&D missions can follow different motives. Facilities either aim to conduct R&D abroad to be physically proximate to a large target market, leading science and technology, and/or low cost R&D resources. The motive of the R&D facility can be identified by examining the facility age and size, the key and supporting factors in the entry mode decision, the entry mode itself, as well as the importance of different types of collaboration partners in the integration process. Thus the different motives identified are (1) the market motive, (2) the science and technology motive, and (3) the cost motive. In terms of the market motive, a distinction is made between market size and market sophistication. Again, regions may provide an environment for diverse motive types.

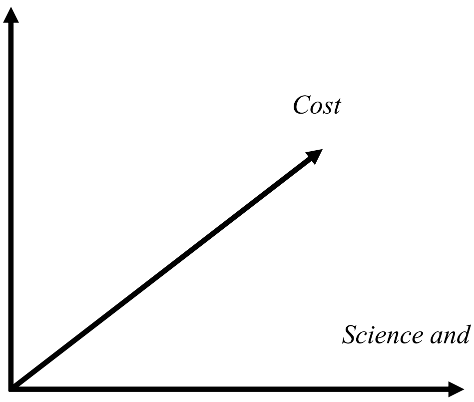


Figure 17: Market-, science and technology-, and cost-motives of R&D internationalization

3.2.4 Behavior

Foreign-owned facilities can furthermore be typified based on their integration behavior once they have located in the RIS. Based on the model created by Saxenian (1994), integration behavior can take on a network-based, or an independent firm-based form. The type of behavior can be identified by examining founding size and growth of the facility, the character of the knowledge work (collaborative/proprietary), the size of partner networks, the nationality of the R&D facility leadership, the entry mode, the collaboration partner types, and the networks used to access the regional knowledge pool. A distinction is made at this point between network-based behavior as a virtue, or network-based behavior as a necessity. In terms of university collaborations, a distinction is made between science-driven collaborations, and recruitment-driven collaborations.

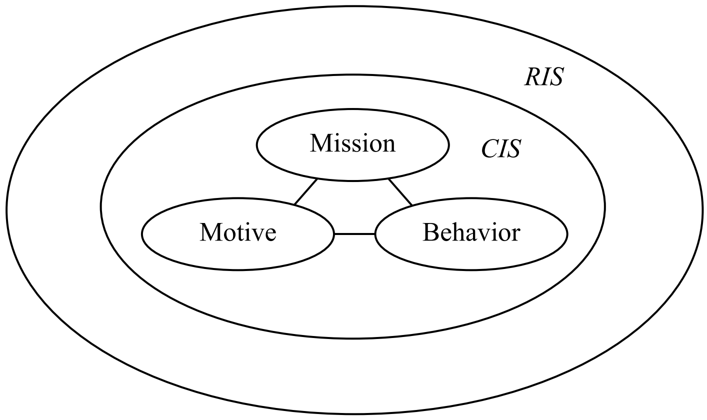


Figure 18: The mission-motive-behavior (MMB) model

The following section presents each of the five regions from an intra-regional perspective, while indicating which of the regional characteristics identified attract which types of foreign-owned R&D facilities according to the MMB model. The section's aim is to identify regional trends in the internationalization of R&D. The section that then follows further below with a global perspective has the aim of identifying global trends in the internationalization of R&D.

3.3 Summary: variables and their meaning for the MMB model

This study contains a fairly large number of variables and some of the variables can take on quite a large number of values, which in turn is to blame for the high levels of heterogeneity in the data set. However, while consolidation of data was conducted to create more homogeneous clusters, this consolidation was limited to prevent the loss of significant indications. The large number of variables qualifies the study to be used as a work of reference for future in-depth research on individual fields that are only touched upon in this analysis. The MMB model was conceived particularly to describe foreign-owned R&D facilities in different regional environments: Do they come to conduct research or development? Do they come to be close to the market or close to technology, potentially even close to key customers? How do they behave when entering and integrating with the regional innovation environment? In the sections that follow, each of the variables is discussed within this framework.

Section 4: intra-regional analyses

4.1 Characteristics of foreign-owned R&D facilities

4.1.1 Introduction

The following section contains intra-regional analyses covering characteristics of foreign-owned R&D at the five locations, the background of their locations decisions, as well as their entry and integration behavior. At the end of each subsection, boxes with implications for policy makers and R&D managers are added. These boxes are not part of the scientific analysis, but instead represent starting points for putting the academic study and its findings into practice.

The Beijing typology gives reason to expect development-driven foreign-owned facilities, following mainly market and cost motives with necessity-driven network-based integration behavior. Due to the highly specific cultural and economic context, the large Chinese market and the fast rate of change, mainly proprietary and HBE R&D, but especially development, is to be expected. Due to the large amounts of inexpensive, highly skilled personnel, cost motives will be of central relevance. Science and technology motives will be of relevance only in limited cases. The gatekeeper role played by the Chinese government as well as the importance of the guanxi networks will require networking as a necessity for RIS access.

The London typology gives reason to expect a diverse population of research- and development-driven, large-sized R&D facilities, following market motives rather than science and technology (S&T) or cost motives. Integration behavior is expected to be of the independent firm-based type, with university collaborations mainly implying recruitment-collaborations rather than S&T-collaborations. Due to the long history of greater London as a recipient of FDI, facilities here will be large and more aged, with broad R&D responsibilities for the European markets. Due to the cultural proximity between the US and the UK, regional integration should not present facilities with great difficulty. However, due to the large company population of the RIS, integration behavior, once again can be expected to be of the independent firm-based type.

The Cambridge typology gives reason to expect research-driven, small and slow growing foreign-owned R&D facilities. Their motives are expected to be mostly S&T-driven.

Integration behavior, due to the collaborative character of the RIS, is expected to be network-based rather than independent firm-based. Since the industrial exploitation of university knowledge has only begun to develop here since the 1990s, Cambridge facilities should be fairly young and small. The lack of market proximity or companies conducting large scale marketing and sales activities in the region should lead to a research-focus of the RIS. The high cost of living would exclude any cost motive for foreign-owned R&D in the region. Due to the openness of academic research, the necessity of strong ties within the Cambridge scientific community, as well as the fact that most local decision makers know each other personally, collaborative, explorative research can be expected. Partnership networks will probably be university-centric and fairly small, given the limited size of the Cambridge RIS.

The Stockholm typology gives reason to expect development-driven facilities following S&T- in combination with lead market-motives (in terms of market sophistication rather than size). Taking into account the Swedish culture for collaboration (Saperstein and Rouach, 2002), as well as the close-knit network of industry leaders in the Stockholm RIS, integration behavior is expected to be network- and virtue-based. The small domestic market combined with technology leadership in clearly defined segments would cause global high-tech companies to place small R&D centers in the region for technology-scanning, -development, and -design. Facilities should be fairly young and not growing very quickly, while partnership networks would be expected limited in size. The relative technological monoculture of the Stockholm RIS (clear focus on wireless technologies) leads to expect that it was highly exposed to the global slowdown in technology demand since the turn of the millennium.

The Munich typology gives reason to expect a population of foreign-owned R&D centers similar to that of the London RIS. Both locations are urban centers with proximity to large markets so both should host a diverse population of foreign R&D facilities in terms of their mission, while more market- than S&T-driven. Both, in terms of the integration behavior encountered should be independent-firm-based in their nature. Because Munich developed as a high tech region later than London did, facilities here should be younger. However, due to the larger cultural distance between Germany and the US, and the greater urban centralization of the UK as opposed to Germany, a smaller overall number of foreign facilities is to be expected in Munich than in London, and management nationality should be more of an issue regarding integration. Due to the triple-helix typology associated with the Munich RIS, motives may be slightly more S&T driven than in London, while the integration behavior may be more virtue- than necessity-driven.

4.1.2 Characteristics of foreign-owned R&D in Beijing

4.1.2.1 THE BEIJING SAMPLE

The Beijing sample consists of 17 foreign-owned R&D facilities located within greater Beijing. In total, China, principally the locations of Shanghai, Hong Kong, and Beijing, hosted around 200 foreign-owned R&D facilities in early 2004, while Beijing hosted roughly one third of this population. This estimate was made based on several databases in collaboration the University of Tsinghua School of Economics and Management. The sample thus covers around nine percent of the foreign-owned R&D facilities in China in early 2004, and around 26 percent of the foreign-owned R&D facilities in Beijing. The facilities examined primarily came from ICT and life sciences sectors. Their home countries were the USA, Japan, and several European countries. The profile of the Beijing sample is shown in Table 8 below.

	USA	Japan	Europe	Total
ICT	7	3	1	14
Life Sciences	1	0	4	2
Others	0	0	1	1
Total	8	3	6	17

Table 8: The Beijing sample

4.1.2.2 BEIJING R&D MISSIONS

The R&D missions of the foreign facilities in the Beijing sample vary considerably, with a clear tendency towards development. Figure 19 shows the missions of the facilities examined in a table as well as a histogram overview. As indicated above, The average R&D mission in the sample is at 63, with a standard deviation of 32, indicating both the tendency towards development as well as the heterogeneity of R&D missions within the sample.

Facility	***R&D mission***				
	100	***75***	***50***	***25***	***0***
1			■		
2		■			
3		■			
4			■		
5		■			
6		■			
7					■
8		■			
9	■				
10			■		
11			■		
12	■				
13	■				
14	■				
15	■				
16		■			
17				■	

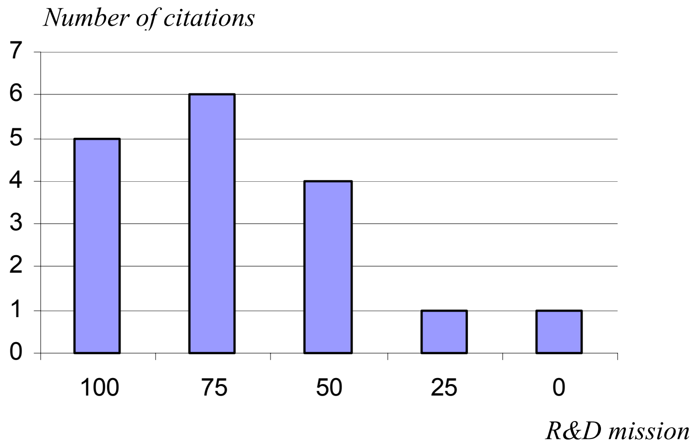


Figure 19: Beijing R&D missions

Regardless of the clear tendency towards development, the picture is heterogeneous. Pure play development facilities in Beijing typically aim to adapt Western technologies to the Chinese market, and/or develop products specifically for the Chinese market based on home country technological knowledge. R&D here is therefore mainly HBE. The main attraction for these activities is the 1.3 billion Chinese consumer market. When proximity to central regulatory bodies and government investment decisions is required, R&D facilities will locate in Beijing rather than in Shanghai. Dual R&D missions indicate facilities conducting research AND development locally. These, typically larger facilities, benefit from the availability of high potential/low cost scientific personnel in the RIS. Large, foreign-owned dual R&D facilities in Beijing either (1) hold global product mandates and operate together with local manufacturing or (2) research and develop technologies specifically for the Chinese market environment (i.e. ICT solutions for five million employee corporations), or technologies that would be considerably more expensive to research and develop in the home country. Pure play research facilities potentially entertain close links to the government, applying Western knowledge to research on scientific questions emerging from the Chinese environment. A point is made of the fact that the technological level of Chinese engineers and scientists often remains inferior to that of their Western counterparts. Chinese R&D staff must therefore be trained and to brought up to speed with the company's technological standard, which is considered an investment of the parent company into the future of its Beijing R&D facilities.

The political importance of operating R&D facilities in Beijing in order to be granted market access indicates a possible fourth dimension to the motives that drive the internationalization of R&D – the political motive. This motive complements the original three motives that were (1) market-driven, (2) science and technology-driven, and (3) cost-driven.

4.1.2.3 BEIJING FACILITY AGE

Foreign-owned R&D in Beijing is a fairly young phenomenon. The opening up of the Chinese economy increasingly encouraged global companies to open R&D facilities in China starting in the late 1990s, so that most of the facilities in the Beijing sample were indeed founded within the last ten years. Some of these facilities are still very young and are considered to be in experimental stages. Figure 29 indicates the facility ages in a table and a histogram. The average age of the facilities is 4.8 years, with a standard deviation of 4.1 years.

Facility	*Age group (years)*			
	1-2	*3-4*	*5-6*	*7+*
1			■	
2			■	
3		■		
4		■		
5		■		
6		■		
7			■	
8	■			
9	■			
10			■	
11			■	
12		■		
13				■
14		■		
15	■			
16			■	
17	■			

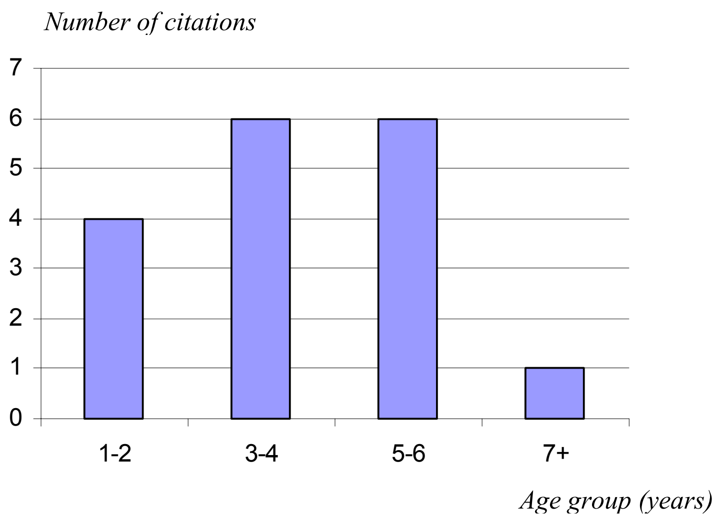


Figure 20: Beijing facility age

The young age of the foreign-owned facilities in Beijing indicates the very specific character of the Beijing RIS implied by fast-changing business environments, also in the field of R&D. From a lifecycle perspective, the Beijing RIS is in its growth phase, compared to leading RIS in Europe that are much more mature. In Beijing, uncertainty is therefore high and change takes place abruptly. Regardless of the cultural differences between the West and China, the number of foreign-owned R&D facilities in Beijing is increasing quickly. The young foreign-owned R&D facilities in the Beijing RIS are the latest indication of Western companies' intent to gain access to the large Chinese market. The R&D motive, in a market-driven sense, is characterized by the fact that Western companies improve their chances at market access if they indicate to the Chinese government that they in return willing to bring Western knowledge into the Beijing RIS by setting up a R&D facility. The R&D motive, in a cost-driven sense, has been indicated above. As the Beijing example illustrates, MNC are globally seeking high quality/low cost locations for large scale R&D facilities.

4.1.2.4 Beijing facility size (March 2004) and growth

The level of R&D commitment, expressed among other things by size and growth of foreign facilities, is a particularly interesting in the Beijing RIS due to the explicit interest of the Chinese government to gain access to Western technologies. Reference is taken to the imperative of reciprocity, described above. Figure 21 shows the size distribution within the Beijing sample as well as a histogram indicating the number of cases for each age group. The average size of the facilities in the sample is 104 R&D staff, with a standard deviation of 112. The average growth rate (not separately indicated in the figure) is 21 R&D staff per annum, with a standard deviation of 25.

Facility	*Size group (R&D staff)*					
	1-50	*51-100*	*101-150*	*151-200*	*201-250*	*251 +*
1	■					
2					■	
3						■
4	■					
5						■
6	■					
7				■		
8	■					
9		■				
10	■					
11		■				
12	■					
13	■					
14		■				
15	■					
16					■	
17	■					

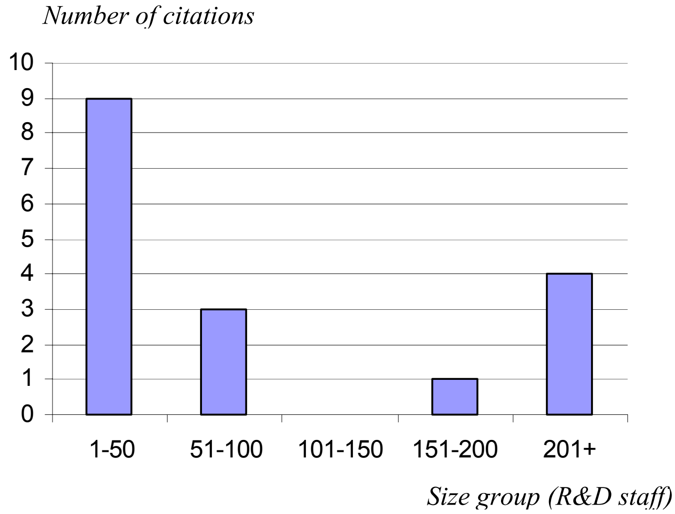


Figure 21: Beijing facility size (March 2004) and growth

Facility sizes in Beijing in March 2004 varied widely. However, the largest part of the facilities had either less than 51 R&D employees or more than 151, indicating two distinctly different clusters of commitment within the sample. The largest facilities sought cost advantages not only by conducting R&D in Beijing, but by giving Beijing subsidiaries full global product mandates for research, development, design, and manufacturing of certain product groups. Smaller facilities were less cost-driven in their motive, but were just as market-driven. Those facilities that started out large continued to grow to become even larger, whereas smaller facilities grew but stayed fairly small, leading to the conclusion that the level of foreign companies' R&D commitments in the Beijing RIS is defined at their outset. Only two facilities in the sample started with below average sizes only to develop above average sizes by 2004. From the integration behavior perspective, the two size-clusters indicate that smaller stand-alone foreign-owned facilities exist in Beijing as well as larger add-on facilities. While the larger facilities benefit from integration through the previous presence of parent company facilities, smaller stand-alone facilities will face a more comprehensive integration process. The fast growth of the facilities indicates that size benefits integration as an indication of commitment to the region. The data furthermore indicates that development facilities were slightly larger than research facilities.

4.1.2.5 Beijing R&D Manager Nationality

The R&D manager nationalities in the Beijing innovation system illustrate a distinctive model. Since the United States is home to many Chinese born US citizens and most of the companies in the sample are from the US, the sample has a large share of 'dual nationality type' R&D managers, well integrated with the parent company and also well able to navigate through the Chinese culture and the Beijing RIS.

Table 9 shows the management nationality distribution for facilities from the US, Japan, and Europe. As indicated, the overwhelming majority of the facilities in the sample employ either home country or dual-type nationality management, indicating a wish for control over local R&D activities. Japanese companies have a tendency to employ home country managers in other foreign countries around the world as well, possibly due to Japanese management culture. The European firms in the sample employ both home and host country nationals.

	USA	**Japan**	**Europe**	**Total**
Home country national	4	3	3	10
Dual type national	4	0	0	4
Host country national	0	0	3	3
Total	8	3	6	17

Table 9: Beijing R&D manager nationality

From the perspective of integration behavior, the dual and host country nationalities indicate a greater wish for integration in the Beijing RIS than the home country nationalities. However, it is not possible to conclude network-based or independent firm-based integration behavior as a result. A look at the regional typology associated with Beijing however indicates that integration here is necessity rather than virtue, as market access depends on the use of guanxi and market access is dependent of being granted access by the government. It is thus concluded that dual and host country nationality may facilitate the integration process in a necessity- and network-based integrations process.

4.1.2.6 BEIJING CHARACTER OF KNOWLEDGE WORK

Explorative versus exploitative aim in Beijing

As indicated in Figure 22, ten facilities out of the sample of 17 tended more or less strongly towards exploitative work, five tended more towards explorative work, and 2 were unable to provide information.

Facility	*Explorative*					*Exploitative*	*n/a*
	100/0	*80/20*	*60/40*	*40/60*	*20/80*	*0/100*	
1			■				
2					■		
3					■		
4					■		
5						■	
6				■			
7		■					
8		■					
9					■		
10			■				
11					■		
12							■
13							■
14					■		
15					■		
16					■		
17		■					

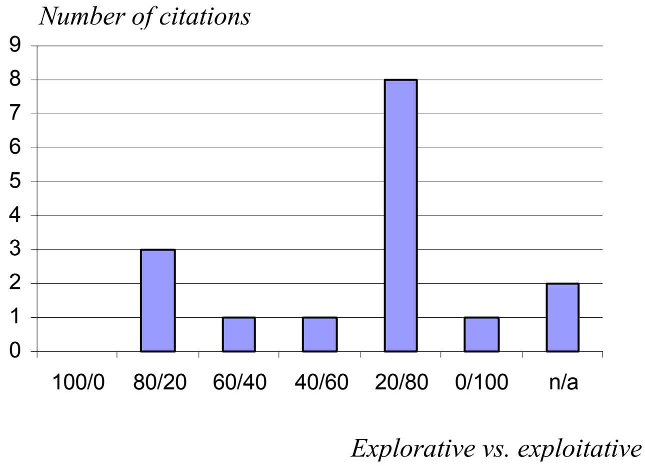


Figure 22: Beijing explorative vs. exploitative knowledge work

The development orientation of the RIS correlates with the focus on exploitative knowledge work, indicating, in the sense of Kümmerle (1998), a stronger focus on HBE activities than on HBA activities. The facilities that did cite their activities as being explorative were those that researched and developed China-specific technologies in a home base augmenting fashion.

4.1.2.6.1 Collaborative versus proprietary aim in Beijing

As indicated in Figure 23, eight of the 17 facilities tended more or less towards collaborative work, while seven tended towards proprietary work.

Facility	*Collaborative*					*Proprietary*	*n/a*
	100/0	*80/20*	*60/40*	*40/60*	*20/80*	*0/100*	
1		■					
2		■					
3		■					
4					■		
5		■					
6			■				
7		■					
8				■			
9		■					
10						■	
11					■		
12							■
13							■
14						■	
15				■			
16					■		
17		■					

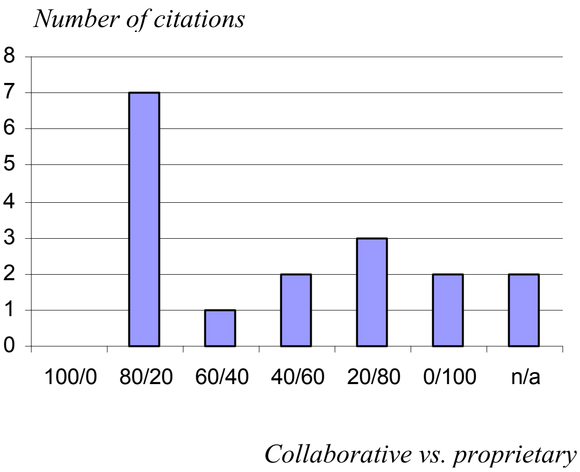


Figure 23: Beijing collaborative vs. proprietary knowledge work

Again, two facilities provided no information. While some of the facility managers indicated that collaborative approaches to their R&D were necessary to gain access to the Chinese innovation systems and distribution networks, others indicated that high levels of imitation and technology dispersion required them to conduct work in a fashion as proprietary as possible. Both the necessity-based collaboration view, and the threat of imitation view, are central aspects of the Beijing RIS, explaining why no clear tendency emerges from the above figure. In fact, the balancing out of collaborative and proprietary R&D has proved one of the most important and most controversial aspects of foreign-owned R&D in the Beijing RIS.

4.1.2.6.2 Tacit versus explicit knowledge work in Beijing

As indicated in Figure 24, the data shows a very slight tendency towards explicit knowledge. Most respondents claimed that both types of knowledge were important.

Facility	Tacit					Explicit	n/a
	100/0	80/20	60/40	40/60	20/80	0/100	
1					■		
2				■			
3		■					
4				■			
5			■				
6				■			
7					■		
8		■					
9			■				
10					■		
11					■		
12							■
13							■
14					■		
15					■		
16			■				
17		■					

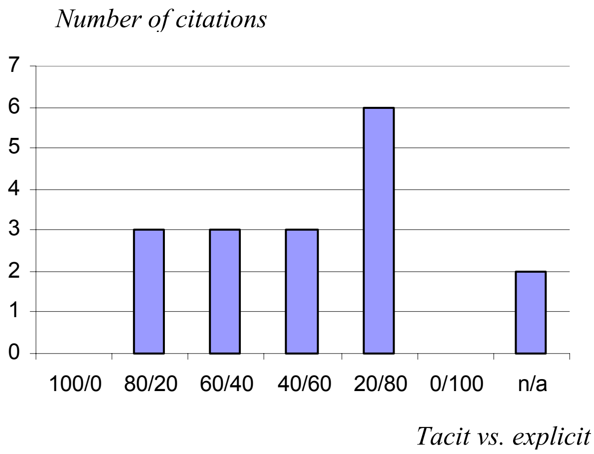


Figure 24: Tacit versus explicit knowledge work in the Beijing sample

A tendency towards explicit knowledge would make sense, given that Beijing is a place mainly for home base exploiting R&D. However, leveraging explicit knowledge developed by the home country in the foreign Chinese environment without doubt requires elements of tacit understanding as well. The Beijing sample therefore implies that to leverage explicit scientific knowledge in a foreign environment, additional and new tacit knowledge may be needed, knowledge that is region-specific while at the same time critical to the success of R&D in the foreign environment. In any case, the original supposition that development-drive would correlate with explicit knowledge holds in the case of the Beijing RIS.

4.1.2.7 BEIJING SIZE OF PARTNER NETWORKS

As indicated by Figures 25 and 26, the average number of key partners in the sample was 8.3 (standard deviation 7.9), while the average number of other partners was 37.5 (standard deviation 77.3). The ratio of other partners to key partners on average was thus 4.5. The fairly large standard deviations show the heterogeneity of partner network sizes in Beijing.

Facility	*Number of key partners*					*n/a*
	0-4	*5-9*	*10-19*	*20-29*	*30+*	
1			■			
2					■	
3			■			
4		■				
5						■
6		■				
7			■			
8	■					
9	■					
10	■					
11		■				
12	■					
13				■		
14						■
15	■					
16			■			
17		■				

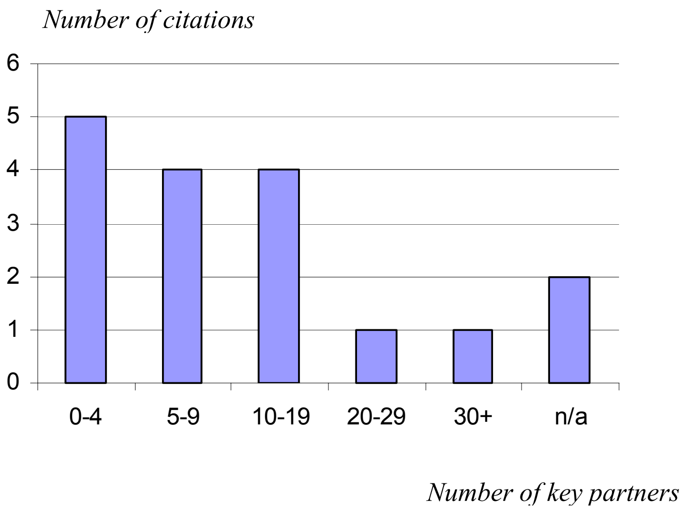


Figure 25: Beijing size of key partner networks

In some cases, the other partner networks are not much larger, sometimes even smaller than the key partner networks. Such cases indicate partnership behavior of depth rather than breadth, supporting the case for necessity-driven collaboration behavior in the Beijing RIS. Thus, the facilities in the Beijing RIS show independent firm-based integration behavior based on the sizes of their key and other partner networks, complemented by in depth networking at locations where this is necessary to achieve their R&D missions.

Facility	*Number of other partners*					*n/a*
	0-9	*10-19*	*20-49*	*50-99*	*100+*	
1		■				
2					■	
3	■					
4		■				
5						■
6	■					
7			■			
8	■					
9		■				
10	■					
11	■					
12					■	
13		■				
14						■
15	■					
16				■		
17	■					

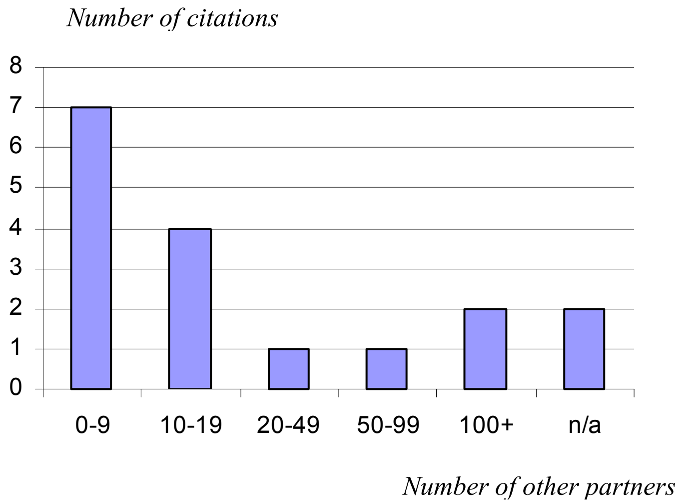


Figure 26: Beijing size of other partner networks

4.1.2.8 CONCLUSION: CHARACTERISTICS OF FOREIGN-OWNED R&D IN BEIJING

This part of the research examined key characteristics of 17 foreign-owned Beijing R&D facilities. While the picture is heterogeneous, key characteristics emerge from the empirical data: the facilities in the sample are more development- than research-driven. However, the trend towards research is increasing as the technological skills of Chinese companies, graduates, and scientists improve. The R&D facilities covered in the sample are young, mostly less than seven years old. New R&D facilities are founded to gain access to and adapt to the Chinese market, and to benefit from low R&D personnel costs. Some large companies have given their Chinese facilities global product mandates for research, development, design, and manufacturing – which may become a trend as the globalization of R&D continues. R&D facilities in the sample varied in size, mostly starting out small (less than 20 R&D staff), but growing quickly. The broader the mission of the facilities, potentially spanning the entire R&D value chain, the larger the facilities. Examining the nationalities of facility management shows that control-driven nationality types dominate over the local integration nationality types. Beijing is determined in part by the unique dual-nationality type model, enabling control and integration at the same time. The character of foreign R&D in Beijing tends towards exploitative, proprietary, and explicit knowledge work. The sizes of Beijing partner networks varied widely, to be evaluated in the context of partner network sizes of other regions in the global analysis that follows. Partnership networks in Beijing more than anything followed market access aims, using partners as 'promoters' to gain access 'gate keepers' of the Chinese market and investment projects. Integration behavior based on these insights can thus be characterized as independent firm-based but with focused network-based behavior where necessary. Table 10 summarizes these findings. Care should be taken when evaluating this data (collected in early 2004), since the speed of economic change in China is extremely high.

	Foreign-owned facilities in Beijing
Mission	More development- than research-driven
Motive	Mostly market access-driven and cost-driven
Behavior	Mostly independent firm-based with necessity-based networking
Age	Young - mostly less than seven years old
Size	Two clusters: (1) 50 and less, (2) 150 and more
Growth	Fast growth of small and large facilities
Management nationality	Control-driven management nationalities dominate
Character of knowledge work	Tendency towards exploitative, proprietary, and explicit
Size of partner networks	Most key and other networks number less than 20

Table 10: Summary of foreign facility characteristics in Beijing

Implications for policy makers

The globalization of R&D in search of cost advantage is underway. This dynamic relates to development as well as research, as demonstrated by MNC subsidiaries with global product mandates in the Beijing area. This globalization could well lead to an increasing relocation of R&D from Western nations to China. Western nations must therefore invest into the quality of their own regional innovation systems to retain competitiveness by differentiation to outweigh the cost disadvantage. The quality of RIS such as Beijing can be expected to improve quickly as MNC themselves are investing heavily, for instance into educational projects in China, in order to attain Western levels of quality at Chinese levels of cost.

Is the trend of foreign-owned R&D in Beijing sustainable? The Chinese government should be aware of the fact that some Western companies are putting up R&D facilities in China only to please the government and be granted access to the Chinese market. Such facilities may conduct less R&D on site than they actually claim.

Should the economic development of China slow down or the political or social stability be at risk, FDI in R&D may well decrease sharply. R&D facilities do not require nearly as much capital investment as manufacturing facilities for example, so that small R&D sites can easily be shut down at one location and reopened at another location. Therefore, continued growth but especially continued and increasing stability of economic and political systems are crucial to sustain the trend of foreign-owned R&D in China.

In Beijing, small foreign-owned facilities grew slower than large facilities, so that they remained small, while large facilities were still larger even after several years in the region. This fact gives policy makers a way of evaluating regional commitment and thus sustainability of the investment. It appears that the level of commitment over the next years already becomes apparent at the outset of the investment. Furthermore, the insight that the largest facilities in Beijing were primarily seeking cost advantage while the smaller facilities were primarily seeking science and technology, shows that to be sustainable, smaller and larger foreign facilities seek different types of input.

The influx of R&D investment into China is greatly facilitated by Chinese-born US citizens acting as managers to the foreign-owned facilities. These individuals bridge the gap of cultural distance by enabling a two-way integration with the region and the parent company. With such personnel at hand, companies greatly increase their international absorptive capacity with respect to setting up operations in China. With continuing globalization, regional policies around the world need to recognize the importance of individuals able to bridge this cultural gap. Investments should be made into international research and other academic exchange programs in order to establish natural links between established Western regions and emerging Eastern regions, for example.

In Beijing, the integration process involves networking described above as necessity-driven rather than virtue-driven. Policy makers should observe that the size of key and other partner networks vary considerably between facilities, and that external collaboration must not be of interest to all foreign-owned R&D facilities. In the case of Beijing, it could also be described as being exploitative rather than explorative. When aiming to improve regional networking infrastructures through policy measures, knowing to which extent networking is virtue- or necessity-driven is an important insight. In the case of Beijing, taking into account the Chinese business culture and the large cultural distance to Western nations, policy initiatives aimed at supporting networking should enable networks of depth rather than networks of breadth.

Implications for R&D managers

In numerous cases, the young age and fast growth of the foreign-owned R&D facilities in Beijing indicate the experiment that is currently going on there. MNC principally need to cope with two main drawbacks in the region. (1) the inferior technological knowledge of Chinese graduates and scientists, and (2) the high levels of imitation and reverse engineering characterizing the Beijing RIS. Regardless, foreign-owned R&D facilities have been set up at unprecedented speed regardless of a global slowdown in technology demand since the year 2000, and all within the context of a communist regime, weak IPR, and the danger of economic bubbles. These *facts indicate that MNC investing with R&D in Beijing are taking a risk. They are counting on the fact that domestic Chinese demand will one day justify the investment, as will the eventual quality of Chinese engineers and scientists that they are currently helping to train and educate. They believe that the cost advantage of conducting R&D in China will improve their global competitive positions as they give global product mandates to Chinese facilities. They furthermore believe that the risk of imitation and reverse-engineering by Chinese competitors does not outweigh the potential benefit of conducting R&D in the region. The current situation seems to imply that these MNC are right. However, in an unstable economic and political system, such discussions are really only possible ex-post. Therefore, companies contemplating an R&D investment in China need to carefully evaluate the opportunities and threats in the context of their own strengths and weaknesses.*

Is the fast growth in the number of foreign-owned R&D facilities in Beijing justified or just a hype? Foreign R&D facilities' size and growth rates typically indicate their parent companies' commitment to the region, and thus give an indication of the region's quality or potential quality as an R&D location. However, fast growth in the Beijing RIS does not necessarily indicate the quality of the RIS. Since the region is young, it is bound to grow faster than established regions such as London or Munich. Furthermore, the growth of the foreign-owned facilities in Beijing may follow different motives for different companies. As indicated above, these motives can be market-, technology-, cost-, or even politically-driven. When conducting R&D location decisions based on the size and growth of other foreign-owned facilities already present in the region, a detailed analysis of the underlying motives needs to be conducted, and these motives need to be compared with the motives followed by the parent company in the internationalization of its R&D.

Regardless of the implied risks, the Beijing example indicates the possibility of conducting R&D in a culturally distant RIS involving far less stability than established R&D locations in the Western world. Once again, this phenomenon is aided by the Chinese-born US citizen phenomenon, while MNC from other home countries however also manage without these individuals.

4.1.3 Characteristics of foreign-owned R&D in London, England

4.1.3.1 THE LONDON SAMPLE

At the outset of the research, the London and Cambridge facilities formed as a single sample. However, the distinct differences that emerged between the facilities at the two locations suggested to examine them in separate samples. The London sample consists of foreign R&D facilities in and around the city of London and its surroundings of up to a one hour driving distance. The sample consists of 12 foreign-owned R&D facilities from ICT and life sciences industries (see Table 11 below). The total population of foreign R&D facilities in the region is difficult to estimate. However it is assumed that the sample constitutes considerably less than ten percent of this population. The London sample consists of facilities in rural as well as urban areas – unlike Beijing, which was strictly urban. Reasons for the greater geographic dispersion of foreign-owned R&D facilities in and around London are the high quality of the infrastructure surrounding London, which enables companies to set up facilities where real estate is less expensive and quality of life for engineers and scientists is higher. Suburban areas in Beijing would not have been developed enough to support foreign-owned R&D facilities.

	USA/Canada	**Japan**	**Europe**	**Total**
ICT	2	2	3	7
Life sciences	2	2	1	5
Others	0	0	0	0
Total	4	4	4	12

Table 11: The London sample

4.1.3.2 London R&D missions

One of the most striking characteristics of the London RIS is its heterogeneity. As shown in the table and histogram of Figure 27, R&D missions in the sample vary widely. However, two clusters of almost equal size can be created – a development cluster and a research cluster. Given London's relative distance from the country's top two university towns (Cambridge and Oxford), the market proximity enabled by the urban center, and the presence of many parent companies' sales and marketing facilities in and around London, a development-orientation within the sample was originally anticipated.

The heterogeneity in R&D missions can best be explained when examining at the motives of the foreign-owned R&D facilities in the London RIS. These motives can for the largest part be described as market-driven rather than S&T- or cost-driven. Thus, both the research and the development facilities in the sample are following the same motive: proximity to the European markets.

Facility	R&D mission				
	100	75	50	25	0
1				■	
2					■
3	■				
4			■		
5				■	
6					■
7				■	
8		■			
9				■	
10		■			
11		■			
12	■				

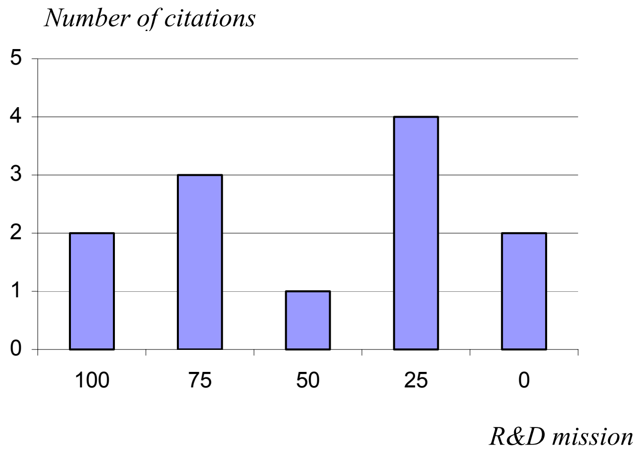


Figure 27: London R&D missions

Figure 27 clearly indicates that the London RIS is neither a pure research, nor a pure development location, nor does it host many dual R&D facilities. This shows that RIS can be of a diversified nature when relating to the R&D missions of their foreign-owned facility population. Research facilities in the London RIS typically hold global product mandates and are thus seen as full-fledged partners in parent companies' international R&D networks. The case of development facilities, the field of responsibility is usually limited to the European markets, focusing on European specificities in product design and specific European regulatory issues.

4.1.3.3 London Facility Age

Figure 28 shows the age of the facilities examined in the London sample. For the most part (ten out of 12 facilities) they were more than ten years old. The average facility age in the sample was 15.8 years (standard deviation 9.9). This shows that founding dates here lie fairly far apart, while the average age is considerably higher than that of the Beijing facilities.

Older, more mature facilities in London have broader areas of responsibility and are, as a result of their age, more integrated in the RIS than younger facilities. This is indicated by the fact that entry and integration as determinants of the facilities' success was not as much of a pressing issue to respondents of older facilities than to those of younger facilities.

Facility	Age (years)		
	1-10	11-20	20+
1	■		
2			■
3		■	
4	■		
5		■	
6		■	
7		■	
8		■	
9			■
10		■	
11		■	
12			■

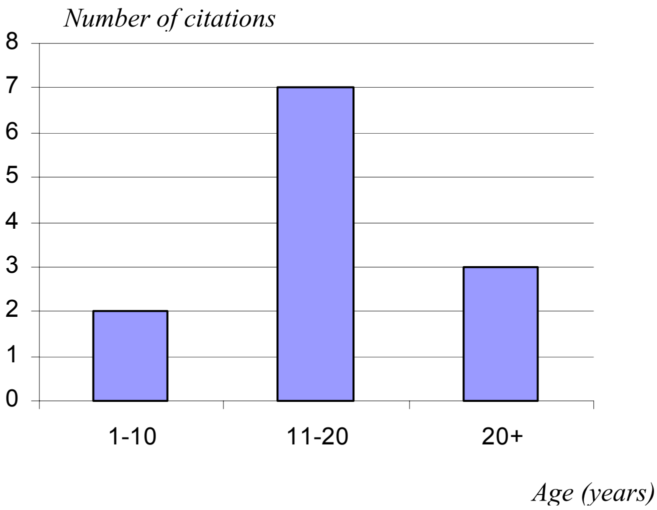


Figure 28: London facility age

The superior age of the facilities in the London RIS indicates that the region has succeeded at satisfying market-driven R&D motives for many years. Since age is one of the best indicators for sustainability of R&D investments, the London RIS would be well suited for future research on sustainability questions. In terms of integration behavior, London respondents indicate that age correlates with the independent firm-based model as facilities grow in size and become self-sufficient with internal knowledge resources. Interestingly however, the data on partnership network sizes further below does not confirm this insight.

4.1.3.4 LONDON FACILITY SIZE (MARCH 2004) AND GROWTH

The size of the foreign-owned facilities in March 2004 and the R&D staff growth rates per annum are also heterogeneous, as shown in Figure 29. The average facility size was 140 R&D employees with a standard deviation of 161, while the average facility growth rate was 3.1 R&D employees per annum (p.a.) with a standard deviation of 12.

As previously noted in the examination of the Beijing RIS, facilities that started out smaller were also smaller in March 2004, indicating once again that the level of the regional R&D commitment over time can be seen as a function of founding size.

Facility	Size (R&D staff)					
	1- 50	51-100	101-150	151-200	201-250	251 +
1	■					
2			■			
3	■					
4	■					
5	■					
6	■					
7		■				
8						■
9				■		
10						■
11						■
12	■					

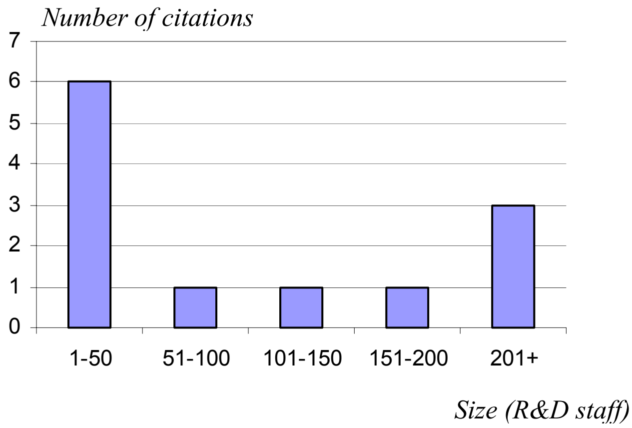


Figure 29: London facility size (March 2004)

Regardless of the heterogeneity in the sample, the London data indicates fairly old facilities with fairly slow growth. Again, as previously seen in Beijing, development centers were slightly larger than research centers. The size of the facilities in the London RIS supports the locally predominant market-driven motive, given the large size of the European markets that attracted these facilities in the first place. In terms of integration behavior, size correlates with age in the sense that internal resources seem to offer a substitute to external collaboration. As indicated above however, even though this may be true, it is not reflected in the sizes of partner networks that follow below.

4.1.3.5 LONDON R&D MANAGER NATIONALITY

The dual type nationalities that were common in Beijing are non-existent in the London sample (see Table 12). Home and host country nationality types are almost equally represented since Japanese companies employed mainly home country nationals as R&D managers. Apparently, and in accordance with insight gained in the Beijing sample, manager nationality is driven not only by the region of entry and its specificities, but also by the culture and characteristics of the investing company. Japanese parent companies seem to tend towards control rather than local integration, while the opposite seems to go for American and European companies with facilities in London, possibly due to issues of cultural proximity.

	USA/CAN	Japan	European	Total
Home country national	1	3	1	5
Dual type national	0	0	0	0
Host country national	3	1	3	7
Total	4	4	4	12

Table 12: London R&D manager nationalities

Cultural proximity in this case would apply mainly to the US and European facilities. These facilities do not see the risk of losing control by putting a local in charge of their R&D facility. It seems that Japanese companies, with greater cultural distance to the UK, would prefer a Japanese executive – at least as a temporary solution to establish dependable command and control structures before a UK executive is eventually put in place. In the long term, local (host country) management is expected to be the most efficient and effective nationality type to enable local integration of foreign facilities. The nationality of management thus gives potential insight into the integration behavior of foreign-owned facilities in London. Home country nationality managers are not automatically as integrated into local networks as host country nationality managers, so that their integration behavior will probably be independent firm-driven rather than network-driven.

4.1.3.6 London character of knowledge work

Due to the heterogeneity of the London sample, the insight gained in this part of the research is not clearly indicative of any distinctive model. However, in the case of explorative vs. exploitative work, the two-cluster approach taken to explain the R&D missions of the London facilities provides a framework for understanding this dimension of the character of knowledge work in the London sample.

4.1.3.6.1 Explorative versus exploitative aim in London

Regardless of a slight tendency towards exploitative work, the distribution in the histogram in Figure 30 is similar to that of the R&D mission histogram – the two clusters on either side of the spectrum are clearly visible.

Facility	Explorative				Exploitative		n/a
	100/0	80/20	60/40	40/60	20/80	0/100	
1		■					
2			■				
3					■		
4					■		
5					■		
6							■
7			■				
8			■				
9				■			
10						■	
11		■					
12						■	

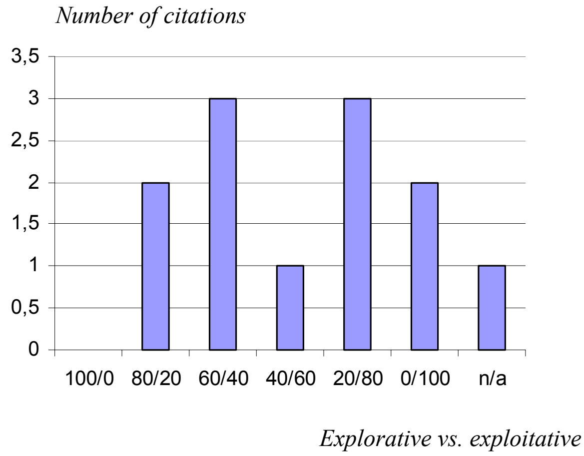


Figure 30: London explorative vs. exploitative knowledge work

In the sense of Kümmerle (1998), facilities in the London RIS are placing a stronger focus on home base exploiting than on home base augmenting activities due to their market-driven motive, characterized by proximity to the urban center of London and the character of London as the gateway to the European markets. The facilities that did cite their activities as being explorative or home base augmenting cited their missions as pure play research centers with global product mandates and profit center character.

4.1.3.6.2 Collaborative versus proprietary aim in London

The data in Figure 31 indicates a clear orientation towards proprietary R&D. Nine of the 12 facilities tended towards proprietary work.

Facility	Collaborative					Proprietary	n/a
	100/0	80/20	60/40	40/60	20/80	0/100	
1				■			
2					■		
3		■					
4				■			
5				■			
6							■
7						■	
8				■			
9			■				
10						■	
11					■		
12					■		

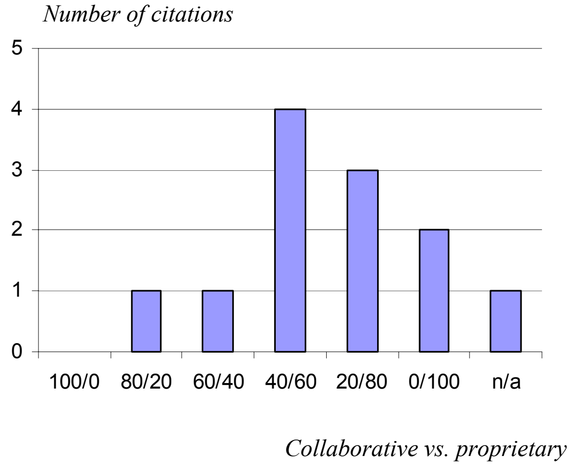


Figure 31: London collaborative vs. proprietary knowledge work

Only two facilities tended towards collaborative R&D. No two-cluster distribution can be identified here. The collaborative versus proprietary dimension seems to be independent of R&D mission. The data furthermore shows that London facilities, regardless of mission, have a proprietary view of conducting R&D, possibly due to the proximity to the market. This supports the view of London facilities as driven by independent firm-based integration behavior. The proprietary character of work here could also be a result of the age and size of the facilities, leading increasingly to R&D going on inside the four walls of the given facility. Furthermore, since the end of the economic boom of the 1990s, collaborative activities in general may have been reduced. Partnerships and alliances in so called business eco-systems (Moore, 1996) may have increasingly given way to more internal and proprietary work.

4.1.3.6.3 Tacit versus explicit knowledge in London

The data in Figure 32 shows a tendency towards explicit knowledge. Seven facilities tended towards explicit knowledge, while four facilities tended towards implicit knowledge.

Facility	*Tacit*					*Explicit*	*n/a*
	100/0	*80/20*	*60/40*	*40/60*	*20/80*	*0/100*	
1				■			
2			■				
3						■	
4					■		
5					■		
6							■
7		■					
8		■					
9				■			
10					■		
11		■					
12				■			

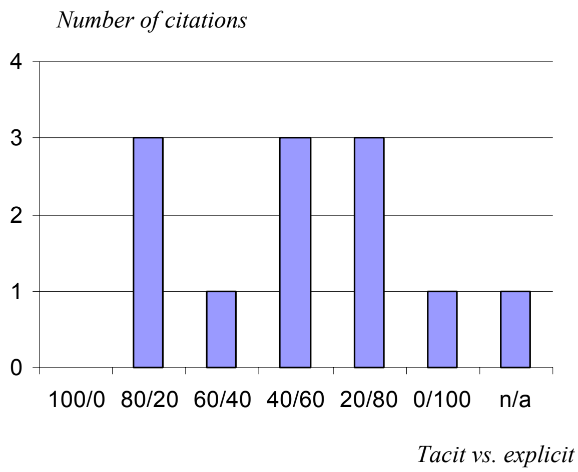


Figure 32: London tacit vs. explicit knowledge work

A slight correlation is identified between the tacit vs. explicit knowledge dimension and R&D mission, indicating that research is considered more tacit while development is considered more explicit. Those facilities that were oriented towards tacit knowledge at the same time were more explorative than exploitative. The tendency towards explicit knowledge is in line with the London sample's exploitative, market-driven nature. Facilities with a clear orientation towards tacit knowledge were all managed by UK nationality managers. Facilities with clear explicit knowledge aims were for the most part (three out of four) managed by non-UK nationality managers. The important insight here is that tacit knowledge may be linked to explorative projects that require deeper regional integration and are thus typically managed by local nationality managers.

4.1.3.7 Conclusion: characteristics of foreign-owned R&D in London

This part of the research, summarized in Table 13, examined the characteristics of 12 foreign-owned R&D facilities in the greater London area. The London sample is characterized by the presence of research AND development facilities in two clusters that give a distinct character to this location. This diversity is attributed to the market-driven motives for conducting foreign-owned R&D at this location. Facilities in the sample are typically more than ten years old, and their growth is slow to moderate. Their size on average is large. These characteristics are explained by taking on a lifecycle perspective indicating the mature state of the London RIS. Whereas Japanese companies employed home country nationality managers, US/Canadian and European companies preferred to employ host country nationals as managers. Thus, Japanese companies may experience lower levels of regional integration than non-Japanese companies, and may be more independent firm-based in their integration behavior than non-Japanese facilities. On average, the sample displays only a weak tendency towards exploitative and explicit knowledge-driven R&D. However, a clear tendency towards proprietary work can be seen in the collaborative/proprietary dimension. This confirms the independent firm-based behavior associated to the London RIS above. Due to a lack of sufficient data, the size of partner networks could not be examined.

	Foreign-owned facilities in London
Mission	Development- AND research-driven sites
Motive	Market-driven
Behavior	Independent firm-based
Age	Mostly more than 10 years old
Size	Two clusters (1) up to 50, (2) more than 150
Growth	Slow to moderate
Management nationality	Host and home country nationals (Japanese: home)
Character of R&D	Tendency towards exploitative, proprietary, explicit

Table 13: Summary of foreign facility characteristics in London

Viewing this data from the perspective of the regional urban-centric gateway to Europe typology established to describe the London RIS, the following points can be made: (1) the urban center apparently attracts development and research facilities alike. This puts it at a clear advantage compared to a rural university town. (2) the geographic location and cultural openness that lead to the gateway to Europe typology have produced large foreign owned facilities here before R&D internationalization picked up at other locations around the world. (3) the two-cluster view of the London RIS applied to R&D mission, facility age, and the explorative vs. exploitative knowledge work dimension. The urban-centric model is thus confirmed in numerous ways, while the diversity of R&D missions under the market-driven R&D motive emerged as a novel insight.

Implications for policy makers

The London sample illustrates that urban centers hold the potential to attract the entire spectrum of foreign R&D - from research to development -, if the location is seen by MNC as a gateway to an important economic area, but with greater cultural proximity than other locations around the world. Therefore, large urban centers and their surroundings should be given special priority in R&D FDI policy. As these RIS build critical mass, they become a self-fulfilling prophecy, diversity being one of their key drivers of competitiveness.

A critical mass of foreign facilities present at a location over a long period of time demonstrates the quality of a R&D region such as London. On the other hand, it may also indicate technological lock-in and club-type networks that are difficult to access for foreigners. Therefore, regional renewal and flexibility through small, innovative firms (Saxenian, 1994) is potentially of critical importance to remain attractive to foreign R&D in the long run. Policy makers' influence on removing impediments to entrepreneurship becomes a central issue in this context.

The London sample illustrates once again that facility age and size are not independent from each other – at least not when taking into account lifecycle models for growth as a function of time. Therefore, slower growth in London was to be expected given the facilities' superior age here. From the perspective of knowledge demand and knowledge supply, additional growth might be possible with an increase in the knowledge supply in the region. Policy makers can influence knowledge supply for instance by supporting university research or attracting knowledge intensive companies to the RIS.

The heterogeneity of the London RIS constitutes one of its key strengths, while at the same time making work difficult for regional innovation policy due to a lack of homogenous innovation needs. Policy solutions need to be based on fairly homogenous target groups of investing companies. One of the aims of this research is to create such target groups for policy makers to address, taking into account the regional typologies, the MMB model as well as the compatibility model (all described above). Policy makers are advised to use these tools to conduct target group analyses with the purpose of attracting foreign R&D to their respective RIS. For instance, integration support may be directed expressly at facilities (i.e. Japanese) with home country management as these facilities will find integration more difficult than facilities with host country nationality management. Furthermore, facilities dealing with large amounts of tacit knowledge may require deeper regional integration that facilities operating predominantly with explicit knowledge.

Implications for R&D managers

The large population of R AND D facilities in and around London shows the value of a large urban center's infrastructure and diversity for international R&D. Managers should thus evaluate closely, which factors would *justify a location decision too far away from such urban centers. Distance in fact is justified in many cases (see Cambridge sample), when key collaboration partners or acquisition candidates are located away from urban centers. From the perspective of the MMB model, urban centers may be the only feasible solution when following market-driven R&D motives. When expressly seeking network-based integration, additional analyses are required, since urban centers vary in terms of their networking behavior.*

As indicated above, an RIS populated by older, larger foreign R&D facilities does not necessarily make this region more attractive to the entry of additional foreign facilities. Entering into such a region (i.e. London) for instance will put the entering R&D facility in competition with the incumbent R&D facilities – for example concerning the best employees and potentially concerning the best collaboration partners. Therefore, locating away from where established players have a solid grip on local knowledge resources may be beneficial, especially if the insurgent facility is small and with limited financial means.

Slow R&D employee p.a. growth rates may indicate facilities' maturity. From the perspective of Schumpeter's widening versus deepening of innovation in a region, this implies the deepening phase. In this phase, innovation processes can be expected to move away from collaborative models and towards proprietary R&D that takes place within the four walls of the mature facilities. Thus, RIS with older, slower growing facilities can be expected to be less collaborative in their nature. When international R&D investments are considered with spill-over aims in mind, this should be considered.

The example of Japanese R&D managers running London-based facilities shows that facilities in foreign environments can in fact be run successfully by home country nationality managers. R&D success in this case is based more on the personal networks of the R&D employees than on networks of the R&D manager. Therefore, companies planning to install home country nationality managers should pay special attention to the availability and quality of the future employees' personal networks. Also, external networking platforms and third party intermediary networks play more important roles where home country managers are employed.

4.1.4 Characteristics of foreign-owned R&D in Cambridge, England

4.1.4.1 THE CAMBRIDGE SAMPLE

The Cambridge RIS encompasses the city of Cambridge and its surroundings, home to numerous technology parks with proximity to Cambridge University. The Cambridge sample consists of nine foreign-owned R&D facilities from ICT and life sciences industries. An overview is given in Table 14 below. Since the population of foreign-owned R&D centers in Cambridge is much smaller than that of London, the Cambridge sample, even though it is smaller, can be expected to be more representative.

	USA	Japan	Europe	Other	Total
ICT	5	2	0	1	8
Life Sciences	1	0	0	0	1
Other	0	0	0	0	0
Total	6	2	0	1	9

Table 14: The Cambridge sample

As described in the regional typology section, Cambridge University is the heart of the Cambridge RIS. While Cambridge is considered one of Europe's leading technology hot-spots, Cambridge is a small place with limited housing and transport infrastructure. R&D in Cambridge thus neither permits fast travel to the US or Japan, nor does it enable direct access to an urban or industrial center. Cambridge is a 'knowledge place'. And so it is perceived by foreign companies setting up R&D there.

4.1.4.2 CAMBRIDGE R&D MISSIONS

Indicated in Figure 33, The Cambridge sample consists of four research- and five development-driven facilities. Interestingly, only one out of the nine facilities examined had a pure play development mission, and none of the facilities claimed dual research and development missions.

Facility	*R&D missions*				
	100	*75*	*50*	*25*	*0*
1		■			
2					■
3				■	
4					■
5		■			
6		■			
7	■				
8					■
9		■			

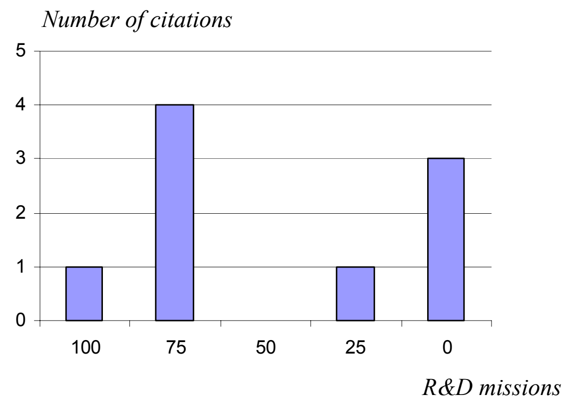


Figure 33: R&D missions in Cambridge

The two clusters indicating simultaneous R and D missions in the Cambridge RIS make it similar in this respect to the London RIS. Compared to the other regions covered in this research the Cambridge RIS displays the strongest tendency towards research. This is explained by the presence of the University of Cambridge, the core and center of gravity of the RIS. However, the research and development facilities in this sample are S&T-driven rather than market- or cost-driven. Development facilities in the sample tend to collaborate with university-spin out companies in and around Cambridge, while research facilities in the sample tend to collaborate directly with the University. As the following analyses will show, Cambridge facilities are much smaller and are more collaboration-driven in their nature, while London facilities, possibly due to their superior age and size, were more self-sufficient.

4.1.4.3 Cambridge facility age

The age of the facilities in the sample, indicated in Figure 34, varied but clustered mainly in the 1-10 and 11-20 year age categories. With an average age of 10.6 years at a standard deviation of 7.9, the Cambridge facilities were on average almost five years younger than the recorded London facilities. A possible explanation for the late surge in foreign-owned R&D in Cambridge are the increasing industry-academia collaborations aimed at commercially exploiting academic knowledge (especially in the ICT industries) that began in the early to mid 1990s. While leading U.S. universities are still ahead, the University of Cambridge has been picking up in terms of industry-academia collaborations. All of the fully research-driven facilities in the sample were founded during the 1990s.

Facility	***Age (years)***		
	1-10	***11-20***	***20+***
1	■		
2	■		
3		■	
4		■	
5	■		
6			■
7	■		
8	■		
9		■	

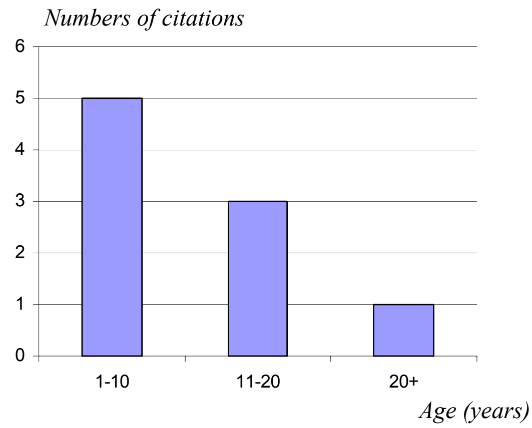


Figure 34: Cambridge facility age

The recent surge of interest in industry-academia collaborations confirms the S&T-driven R&D motive followed by foreign-owned facilities in the Cambridge RIS. This phenomenon is interesting because it shows how a location that has been leading in knowledge production for hundreds of years can all of a sudden attract large amounts of FDI in R&D when the right economic or technological changes occur. Cambridge could thus also be characterized as the 'newly discovered hidden champion' taking reference to the young ages of the foreign-owned facilities in the RIS. However, this also raises the question of sustainability of the facilities. Especially young and research-driven facilities may risk closure in times of economic difficulty, since research tends to be kept closer to headquarters (Zedtwitz, 2002), and because younger foreign facilities may not have had the chance to prove their worth within the global network as much as older facilities may have. Questions of sustainability of foreign R&D investments thus gain special relevance in regions where facilities are young and research-driven, which is the case in the Cambridge RIS.

4.1.4.4 CAMBRIDGE FACILITY SIZE AND GROWTH

The facilities in the Cambridge sample were, indicated in Figure 35, relatively small and displayed modest growth rates. Average size was 65.2 R&D staff at a standard deviation of 42.6, while average growth was 4.6 staff p.a. at a standard deviation of 5.4.

Facility	*Size (R&D staff)*					
	1-25	*26-50*	*51-75*	*76-100*	*101-125*	*126 +*
1				■		
2	■					
3	■					
4		■				
5			■			
6						■
7				■		
8				■		
9		■				

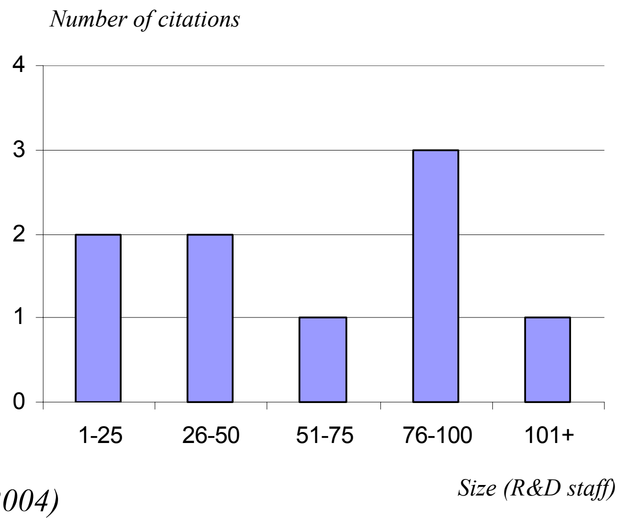


Figure 35: Facility size in Cambridge (March 2004)

Cambridge facilities on average were much smaller than London facilities (65.2 vs. 140). Interestingly, London and Cambridge facilities both displayed similar growth rates (3.1 for London and 4.6 for Cambridge). This shows that even though the Cambridge facilities are younger, they do not grow substantially faster (which distinguishes Cambridge from young, fast growing Beijing). The reason for this could lie in the fact that Cambridge is more S&T-driven than London, and that development sites are expected to grow faster than research sites. The pure-play research sites in Cambridge in 2004 were smaller than the development-driven sites. While foreign companies started out small when investing with R&D in Cambridge and Beijing, they quickly grew their Beijing facilities to reach 'urban center' type sizes as found in the London RIS. This did not happen in Cambridge, once again confirming the 'small is beautiful' typology of the Cambridge innovation system.

4.1.4.5 CAMBRIDGE R&D MANAGEMENT NATIONALITY

Foreign-owned R&D facilities in Cambridge, as indicated by Table 15, most of which come from the U.S., employ local (host country nationality) R&D management.

	USA/CAN	Japan	European	Other	Total
Home country national	0	0	0	0	0
Dual type national	0	0	0	1	1
Host country national	6	2	0	0	8
Total	6	2	0	1	9

Table 15: Cambridge R&D manager nationalities

Even the two Japanese companies in the sample employed UK nationals as R&D managers. The cultural proximity between the U.S. and the UK enable the US companies to control the UK R&D managers with little difficulty, while benefiting from their local integration with the RIS. In the introductory statement on the typology of regional innovation systems above, the importance of university-based personal networks as transfer factors in the Cambridge innovation system are mentioned. The data from the Cambridge sample confirms this, given that most of the managers interviewed in Cambridge had a long history of studying at the University before taking on academic appointments there and eventually becoming R&D managers for foreign owned R&D centers. The conclusion to be drawn in terms of integration behavior for the MMB model is clearly towards a virtue-driven, network-based behavior.

It appears that London facilities, when small, are more often managed by home country nationals, whereas larger facilities are managed more often by host country nationals. The fact that this is not the case in Cambridge might be attributed to Cambridge facilities being more S&T-driven. In this case, S&T-driven facilities would require host country national management more so than market-driven facilities, probably as a result of the greater regional embeddedness of S&T networks. This hypothesis however would need to be researched on in a later work.

4.1.4.6 CAMBRIDGE CHARACTER OF KNOWLEDGE WORK

4.1.4.6.1 Explorative versus exploitative aim in Cambridge

Once again, as indicated by Figure 36, there are two clusters – one indicating explorative aim, one indicating exploitative aim.

Facility	*Explorative*					*Exploitative*	*n/a*
	100/0	*80/20*	*60/40*	*40/60*	*20/80*	*0/100*	
1					■		
2		■					
3	■						
4		■					
5					■		
6						■	
7						■	
8	■						
9					■		

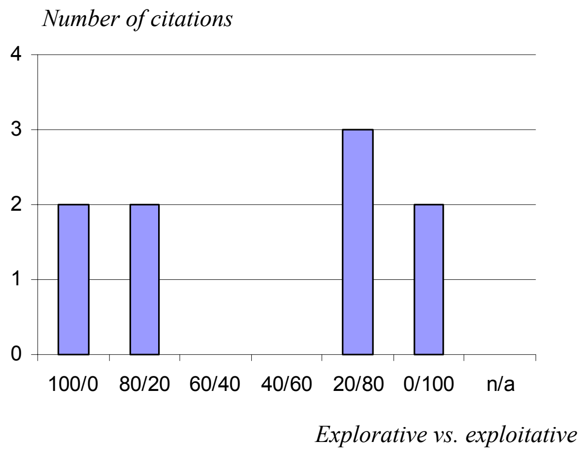


Figure 36: Cambridge explorative vs. exploitative knowledge work

The facilities that cited their activities as being explorative were research-driven facilities that were seeking proximity to the University, whereas the others were development centers that located in Cambridge especially due to the large amount of small technology-driven start-ups present there. In terms of the MMB model, the explorative vs. exploitative dimension correlates once again with R&D mission, indicating both the presence of research and development facilities in the Cambridge RIS. In terms of integration behavior, the insight that one group of facilities primarily collaborates with local technology companies, while the other group collaborates primarily with the university, shows that network-based integration behavior, in the Cambridge case, is directed at different types of local knowledge carriers.

4.1.4.6.2 Collaborative versus proprietary aim in Cambridge

The data in Figure 37 shows that regardless of the fact that Cambridge is an academic, and thus supposedly an 'open' environment, all but two foreign-owned R&D facilities characterized their work as being proprietary as opposed to collaborative.

Facility	*Collaborative*					*Proprietary*	*n/a*
	100/0	*80/20*	*60/40*	*40/60*	*20/80*	*0/100*	
1						■	
2	■						
3	■						
4						■	
5						■	
6						■	
7				■			
8					■		
9				■			

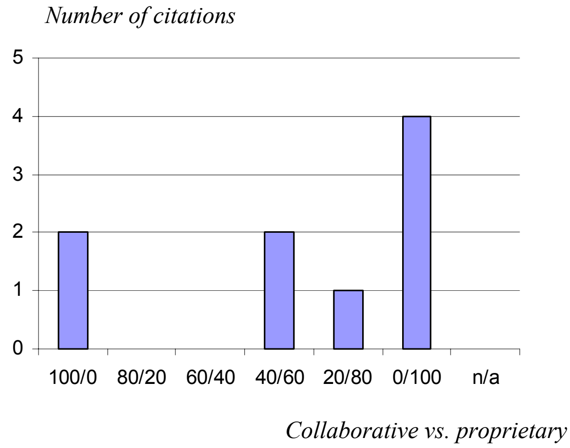


Figure 37: Cambridge collaborative vs. proprietary knowledge work

The data makes sense when taking into account the discussions surrounding IPR ownership in industry-academia collaborations that are currently being held in Cambridge. The arising conflicts of interest between academic science and industrial science have lead Cambridge University to increasingly claim exploitation rights in such joint projects. Cambridge University is following the lead of US universities such as Stanford and MIT, considered to be pioneers in solving university-industry IPR disputes. In two cases however, facilities claimed collaborative knowledge work. They were both small, research driven, and explorative in their R&D approaches, indicating that while IPR issues have made industry-academia collaborations more difficult recently, some companies are willing to enter into collaboration without claiming ownership to the knowledge they help create.

The insight gained here shows once again that the collaborative vs. proprietary dimension does not correlate with R&D mission, except for a few cases in which small facilities explicitly claim to collaborate with universities on an open scientific level. The conclusions to be made concerning the Cambridge facilities' integration behavior are that even virtue-driven, network-based behavior can follow proprietary aims. The Cambridge insight also demonstrates that network-driven R&D potentially requires complicated IPR agreements. Such agreements in fact contradict the notion of explorative collaboration when legal departments have to be contacted before any information can be shared with outsiders.

4.1.4.6.3 Tacit versus explicit knowledge in Cambridge

The nearly equal distribution of cases in each of the categories confirms the original notion that tacit knowledge is more associated with research, while explicit knowledge is more associated with development.

Facility	*Tacit*					*Explicit*	*n/a*
	100/0	*80/20*	*60/40*	*40/60*	*20/80*	*0/100*	
1						■	
2		■					
3						■	
4	■						
5				■			
6					■		
7		■					
8			■				
9					■		

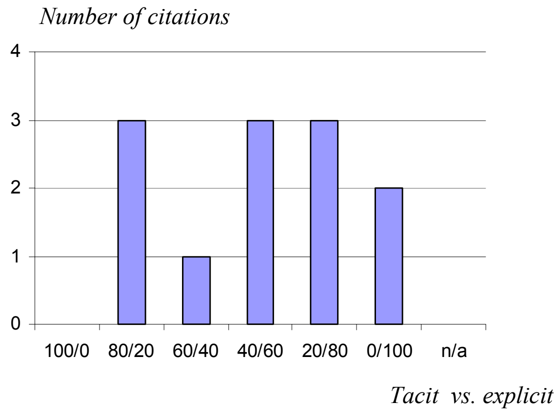


Figure 38: Tacit knowledge versus explicit knowledge in Cambridge

Research-driven facilities for the most part (thee out of four) noted an orientation towards tacit knowledge, whereas the development-driven facilities for the most part (four out of five) noted an orientation towards explicit knowledge. The data on the tacit vs. explicit knowledge dimension furthermore indicates that the type of knowledge is independent of the type of integration behavior. In the case of Cambridge, virtue-driven, network-based integration behavior is conducted in the case of both tacit and explicit knowledge-driven foreign-owned R&D.

4.1.4.7 CONCLUSION: CHARACTERISTICS OF FOREIGN-OWNED R&D IN CAMBRIDGE

Even though Cambridge and London are less than a two hour driving distance from each other and even though they both host foreign research AND development facilities, they represent two distinctly different types of innovation systems. While Cambridge provides a small, S&T-driven environment, London is large and market-driven. Taking a closer look at the differences in motive between London and Cambridge shows that development-driven facilities in Cambridge are more S&T-driven than those in London, while research-driven facilities in London are more market driven-than those in Cambridge. These findings show the wide spectrum of possible R&D orientations within such a close driving radius.

The Cambridge RIS, as summarized in Table 16, hosts foreign-owned research AND development facilities. These facilities follow S&T-driven R&D motives. While the research-oriented facilities mainly seek proximity to the University of Cambridge, the development-oriented facilities seek proximity to the university spin-out companies that populate the RIS. Cambridge's foreign-owned facilities were young and small, with slow to moderate growth. The sustainability of these facilities should be watched closely in order to maintain the competitiveness of the RIS. The character of knowledge work here was more oriented towards explorative, collaborative, and tacit knowledge than any of the other locations examined in this research. The data indicates that tacit knowledge is associated with research, while explicit knowledge is associated with development. At the same time, the data indicates that both proprietary and collaborative approaches to R&D are possible with virtue- and network-based integration behavior. Management nationality was mainly host country nationality, which is until now unique to the Cambridge RIS. It shows how important the personal integration of R&D managers into local scientific and technology networks is as a determinant of foreign-owned R&D facility success.

	Foreign-owned facilities in Cambridge
Mission	Research facilities and development-facilities
Motive	S&T-driven
Behavior	Network-based, virtue-driven
Age	Young
Size	Small
Growth	Slow to moderate
Character of R&D	More explorative, tacit, and collaborative than other regions
Management nationality	Host country nationalities. Local integration favored

Table 16: Summary of foreign facility characteristics in Cambridge

The small is beautiful character of the Cambridge innovation system has confirmed itself in the above observations. The quality of the University and the small firms present here seem to compensate for the lack of physical infrastructure (no international flight connections, extremely limited real estate availability, etc.). This lack however, may not actually be a drawback at all, since the S&T-driven character of the system produces smaller facilities (requiring less infrastructure), and scientific excellence rather than marketing excellence (requiring less market proximity). Hence, the Cambridge innovation system can furthermore be characterized as a system of scientific excellence, that is not so much more research- than development driven, but rather more science and technology- than market-driven.

Implications for policy makers

Until a few years ago, Cambridge was a hidden champion location for foreign-owned R&D. Policy makers interested in developing their region as a location for foreign R&D investment should be aware of the knowledge potential already present within the existing knowledge-supplying elements of their RIS. Unexploited knowledge-potential, when communicated properly abroad, may attract foreign MNC to invest in the region. A clear understanding of the type of knowledge present in the region as well as the potential areas for its application are important prerequisites for any target group-focused regional communications effort. However, the mindset to create international R&D locations must be present not only among policy makers, but also among the scientists and engineers in organizations whose knowledge is considered unexploited. Top-down only approaches alone will thus not lead to success in leveraging hidden-champion locations to foreign investors.

Limited space and infrastructure in and around Cambridge can be seen as a problem, but this contributes at the same time to the unique knowledge-driven environment of the RIS. Respondents in Cambridge repeatedly noted that the proper environment for science-driven R&D is one of close proximity between knowledge-driven organizations and institutions. They furthermore noted that the Cambridge environment is a quiet, small town environment, where most places can be reached by bicycle within a few minutes. It is an elite environment rich in history and pride in what has been achieved here over the past centuries. In Cambridge, you can literally 'feel knowledge in the air'. When policy makers in other parts of the world evaluate which locations to foster in terms of S&T-driven R&D, these considerations should be taken into account. Large urban centers may provide the optimal surroundings for market-driven facilities, but this may not be the case for S&T-driven facilities.

Industry-academia collaborations inevitably lead to conflicts of interest when commercialization of academic knowledge is at stake. For several years, this was not the case. However, universities eventually understood their negotiating positions, increasingly demanding a share of the commercialization returns on the knowledge they helped create. However, respondents from Cambridge indicate the danger in these IPR agreements: in numerous cases, the negotiations were so long and complicated both from economic and political standpoints, that the research and development process suffered substantially in the process. Policy makers in countries where *universities are mainly public, when interested in fostering industry-academia R&D collaborations, face the challenge of how to secure right to the commercialization of knowledge without show-stopping bureaucratic paperwork and agreement procedures. Best practice examples should be examined from leading universities in the US and the UK.*

In the Cambridge RIS, public policy plays little, or no role at all. Individual initiative is at the center of the RIS, and role models play an especially important function. Regional development initiatives, networking initiatives, and foreign investment seeking initiatives are fundamentally driven by private individuals. Networking by virtue seems to be working better here without policy involvement than at other locations with considerable policy support. Policy makers should therefore be careful when attempting to copy best practices from foreign regions to their own RIS, since many of them may be culture-specific and thus not transposable abroad. The insight also shows that regional innovation processes depend to a large extent on personal initiative, the lack of which cannot be fully compensated by policy initiative.

Implications for R&D managers

In the Cambridge RIS, host country R&D facility management plays a more important role than at the other locations studied in this research. As indicated above, the nationality of the R&D manager has important implications for the integration of the facility into the RIS. The small town atmosphere of the Cambridge RIS is characterized by tight personal networks between leading academics and managers. Being part of the Cambridge RIS in essence means being part of these networks. When contemplating on the choice of a manager for the foreign facility, companies need to be aware of the type of networks needed to enable integration. In the Cambridge case, even Japanese companies opted for local management.

Network-driven R&D does not necessarily imply collaborative sharing of research results. The proprietary approach taken by foreign-owned R&D facilities in Cambridge even towards university collaboration demonstrates this fact. However, it also demonstrates that industry-academia IPR agreements are a potentially difficult topic. Embedded laboratories present a special challenge to foreign MNC and the collaborating university. According to local respondents, R&D managers must identify possible areas of conflicts of interest and address them early on in the negotiation process. If full access of the university to the facilities' work is not wished for, then embedded laboratories should not be located directly on university premises.

Small, rural surroundings may be better environments for S&T-driven research than large, urban surroundings. Cambridge respondents were personally very attached to Cambridge, and in many cases claim never having wished to leave Cambridge since they began work there. The quality of life aspect associated with a location for foreign R&D is important not just to create the right atmosphere for knowledge-driven work, but also to reduce job rotation and increase employee loyalty at the facility. This for instance is not the case in Beijing, where respondents complained about lacking employee loyalty among young Chinese engineers and scientists. Thus, companies with long-term, consistent foreign R&D teams in mind may wish to select a location providing the right kind of work culture.

4.1.5 Characteristics of foreign-owned R&D in Stockholm, Sweden

4.1.5.1 THE STOCKHOLM SAMPLE

This section examines foreign-owned R&D facilities located in and around Stockholm, Sweden, a leading RIS for mobile telecommunications, mobile computing, and certain pharmaceutical industries. Even though the region does not host nearly as many foreign-owned R&D facilities as the other regions covered in this research, it is interesting due to the niche character of the innovation system, which lead to a steep rise of Stockholm as a high-tech location during the New Economy, and has likewise lead to a sharp decline in foreign R&D activity since the economic slowdown following the year 2000. Table 17 gives an overview of the Stockholm sample, consisting of seven foreign-owned R&D facilities from ICT and life sciences industries.

	USA/Can.	**Japan**	**Europe**	**Other**	**Total**
ICT	5	0	0	0	5
Life Sciences	0	0	2	0	2
Other	0	0	0	0	0
Total	5	0	2	0	7

Table 17: The Stockholm sample

The cause for the reduction of foreign R&D in the Stockholm area (see Table 18) may be attributed to cost cutting and R&D re-centralization initiatives of large companies, only a few years ago regarding the Stockholm RIS as an avant garde location for wireless technologies of all sorts. The centers of wireless excellence that were frequent in Stockholm in 2001 have in numerous cases been shut-down or reduced considerably in size.

Stockholm foreign direct investment in R&D prior to 2001	Downsized	Closed
Accenture (US): global center for WAP applications and services		X
Motorola (US): development center for wireless applications and services		X
Cambridge Technology Partners (US): global wireless competence center		X
Nokia (Finland): R&D in mobile communication infrastructure		X
Cap Gemini Ernst and Young (France/US): competence center for 3G mobile systems		X
Nortel Networks (Canada): R&D center for datacom, telecoms and wireless communications	X	
Hewlett Packard (US): wireless research and a joint project with Ericsson and Telia		X
Oracle (US): center of excellence for wireless product development	X	
Sun Microsystems (US): center of wireless excellence	X	

Table 18: Stockholm foreign-owned R&D facility downsizing and closures

Furthermore, the number of spin-outs from Ericsson has declined since 2001, as has the interest of global companies to invest into small technology firms in the area. Consequently, Stockholm, as a niche player, has been highly exposed to the economic turbulences since 2000. Its focus on mobile technologies, which was once one of its key strengths, became one of its key liabilities. In January 2004, the foreign-owned R&D facilities identified by this research were mainly development- and service-driven, seeking proximity to key customers and their manufacturing facilities, rather than constituting full-fledged research and/or development facilities.

4.1.5.2 STOCKHOLM FACILITY R&D MISSION

The facilities in the Stockholm sample either have dual R&D missions, or missions that tend slightly towards development over research. None of the facilities displayed a clear tendency towards either pure play research or pure play development.

Facility	R&D mission				
	100	75	50	25	0
1			■		
2		■			
3		■			
4			■		
5			■		
6		■			
7		■			

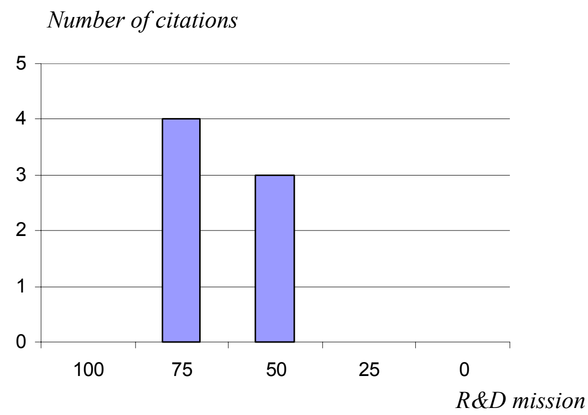


Figure 39: Stockholm R&D missions

As Figure 39 shows, none of the facilities in the Stockholm sample claim pure play research or pure play development. The dual R&D missions identified imply a regional innovation system in which foreign-owned facilities do some research and some development, however without a global product mandate. Instead, facilities operate controlled by and in collaboration with corporate headquarters to serve the needs of the key customers they are located close to.

This data stands in contrasts to the findings from the UK and China, where pure play missions were frequently identified, even if they were not the standard. However, the findings fit well with the characterization of Stockholm as a niche player and lead market, while too small a market to justify full fledged pure play research or development facilities.

The Stockholm sample thus leads to a fifth dimension of motives leading to the internationalization of R&D – the key customer-driven motive. Adding this factor complements the original motives that were (1) science and technology-driven, (2) market-driven, and (3) cost-driven, as well as the fourth dimension, taken from Beijing, which was (4) the political-driven motive.

In terms of the mission perspective of the MMB model, while RIS such as Cambridge and London hosted research facilities and development facilities, but very little facilities with dual R&D missions, the opposite is true for the Stockholm RIS.

4.1.5.3 Stockholm facility age

Figure 40 shows that most of the foreign-owned R&D facilities in the Stockholm sample were less than 10 years old. Their dates of founding correlate with the period of the New Economy, which took off in the early to mid 1990s and ended in the year 2000. Only two facilities were less than five years old. These facilities were founded in or after 2000.

Facility	*Age (years)*			
	1-5	*6-10*	*11-50*	*51+*
1				■
2		■		
3		■		
4	■			
5		■		
6		■		
7	■			

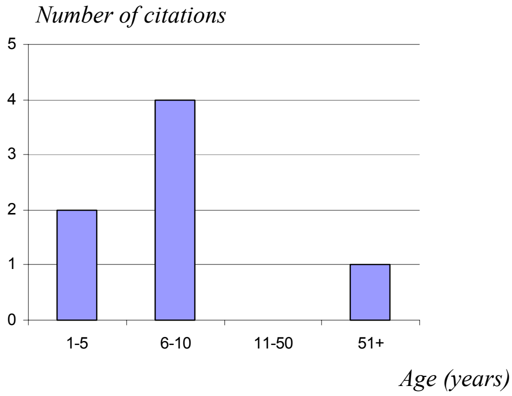


Figure 40: Stockholm facility age

On average, the facilities were 5.5 years old, with a standard deviation of 1.8. Foreign-owned R&D facilities in the Stockholm sample are thus younger than UK facilities and slightly older on average than those in the Beijing sample. If foreign direct investment in R&D occurs in waves or responds to certain trends, this would explain why R&D facilities in different places have different average ages. The Stockholm facilities were for the most part founded during the boom years of the New Economy. Their founding may have been the result of overwhelming optimism and affluent research budgets. As global R&D budgets tightened, Stockholm lost appeal for MNC, and numerous existing facilities were scaled down or shut down completely.

In the sense of the MMB model, the time period of founding of the facilities would indeed indicate S&T-driven motives for setting up foreign-owned R&D in the Stockholm RIS. However, the facilities' current mission descriptions do not fit this motive. The presumption is thus that the motive of foreign R&D facilities in Stockholm has changed with time, from an S&T-driven motive, to a customer-driven motive. The phenomenon of internationalization motives changing with time is, in this research, unique to the Stockholm RIS.

4.1.5.4 STOCKHOLM FACILITY SIZE (MARCH 2004) AND GROWTH

At an average size of 58 R&D employees, the Stockholm facilities are smaller than those in the UK and in Beijing (see Figure 41). This finding confirms the original impression that Stockholm is not a location of full-fledged R&D centers. Instead, foreign R&D in Stockholm is key customer-, service-, and design-driven, and apparently these facilities require fewer personnel than the facilities observed in the other countries. The large standard deviation of 95 reflects one very large facility in the sample that originated from a merger between a local and a foreign MNC.

Facility	*Size (R&D staff)*				
	1-5	*6-10*	*11-40*	*41-70*	*71+*
1					■
2		■			
3			■		
4					■
5		■			
6			■		
7		■			

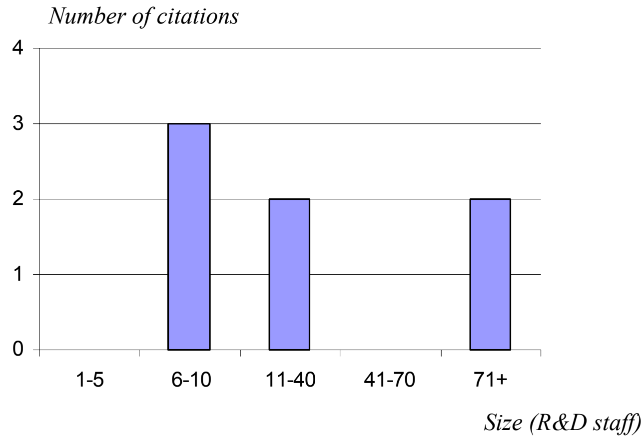


Figure 41: Stockholm facility sizes (March 2004)

The growth of the Stockholm facilities was an average of 9.5 R&D employees p.a., ranking Stockholm second only to Beijing (with 21 R&D employees p.a.). This indicates the success of the foreign facilities in Stockholm. MNC that committed to Stockholm with R&D did so with a limited number of personnel, but increased this number at an above average pace. In summary, the facilities in the Stockholm sample are small, but they grow with rates that lie above the average of the other regions covered in this study with the exception of Beijing.

The small size of the facilities, from the standpoint of sustainability, indicates low levels of capital commitment, which implies in turn that facilities might be shut down easily. However, the growth rates of the facilities over the last few years indicate a growing commitment of MNC to their R&D in this RIS. Therefore, taking into account that many facilities were indeed shut down here between 2001 and 2004, the remaining facilities that have even grown in size since, are considered fairly sustainable. From the motive perspective of the MMB model, the size and growth rates indicate an increasing importance of customer company-driven R&D internationalization and network-based integration behavior.

4.1.5.5 STOCKHOLM R&D MANAGEMENT NATIONALITY

Stockholm sample facilities for the most part had host country nationality R&D managers (see Table 19). This situation is similar to Cambridge, where host country managers were also by far the dominating nationality type. The data could imply one of two things. It either indicates that the Stockholm RIS is culturally proximate to investing companies' home countries, enabling local management without loss of control by the parent company. This proximity could be explained in part by the fact that Swedish proficiency with the English language is very high, much higher than that of Germany or France for instance. On the other hand, it could indicate that networks in Stockholm, similar to Cambridge, are tightly-knit and personal, necessitating local management in order to gain sufficient access.

	USA/CAN	Asian	European	Total
Home country national	0	0	0	0
Dual type national	1	0	0	1
Host country national	4	0	2	6
Total	5	0	2	7

Table 19: Stockholm R&D manager nationalities

In terms of the MMB model and the integration behavior to be expected of foreign-owned facilities in Stockholm, the data once again indicates network-based behavior. The Stockholm RIS is characterized by the small size of the Swedish economy, in which many business leaders have attended the same university and thus know each other personally. Informal, personal networking is thus an integral part of the Stockholm RIS, possibly explaining the employment of locals as R&D managers to the foreign-owned facilities.

4.1.5.6 STOCKHOLM CHARACTER OF KNOWLEDGE WORK

4.1.5.6.1 Explorative versus exploitative aim in Stockholm

As indicated by Figure 42, there is a clear tendency towards exploitative R&D in the Stockholm sample. Five out of seven facilities indicated an exploitative focus, while two facilities indicated an explorative focus.

Facility	*Explorative*					*Exploitative*	*n/a*
	100/0	*80/20*	*60/40*	*40/60*	*20/80*	*0/100*	
1				■			
2					■		
3					■		
4		■					
5					■		
6						■	
7		■					

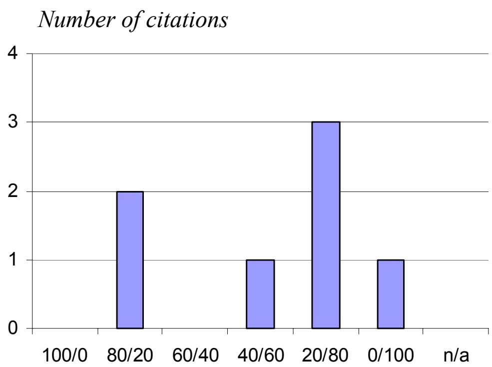


Figure 42: Stockholm explorative vs. exploitative knowledge work

This insight fits with the key customer company-driven motive as well as the development-orientation of R&D missions in the Stockholm sample. From the perspective of integration behavior of the MMB model, the exploitative orientation indicates that R&D collaborations will be sought with customer companies and other types of companies rather than with academic and other types of research institutions. It furthermore points towards independent firm-based integration behavior rather than network-based integration behavior.

4.1.5.6.2 Collaborative versus proprietary aim in Stockholm

The data in Figure 43 does not indicate any clear tendencies towards either of the two sides of the table.

Facility	Collaborative				Proprietary		n/a
	100/0	80/20	60/40	40/60	20/80	0/100	
1					■		
2			■				
3					■		
4	■						
5					■		
6		■					
7				■			

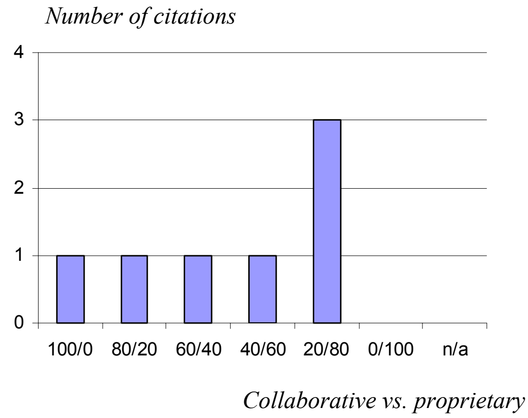


Figure 43: Stockholm collaborative vs. proprietary knowledge work

However, the data does not contradict the key customer company-driven motive or the development-driven mission-orientation earlier identified in association with the Stockholm RIS. Collaborative R&D in this context refers to facilities jointly developing technologies with their key customers, while proprietary R&D refers to facilities conducting R&D in Stockholm due to S&T-driven motives rather than customer company-driven motives. This indicates once again the dual character of R&D motives in the Stockholm RIS.

4.1.5.6.3 Tacit versus explicit knowledge in Stockholm

No clear picture emerges from the data in Figure 44 either. All of the respondents claimed combinations of explicit and tacit knowledge in their R&D work, while most of them even claimed almost equal importance of the two knowledge types.

Facility	*Tacit*					*Explicit*	*n/a*
	100/0	*80/20*	*60/40*	*40/60*	*20/80*	*0/100*	
1					■		
2			■				
3			■				
4			■				
5				■			
6		■					
7					■		

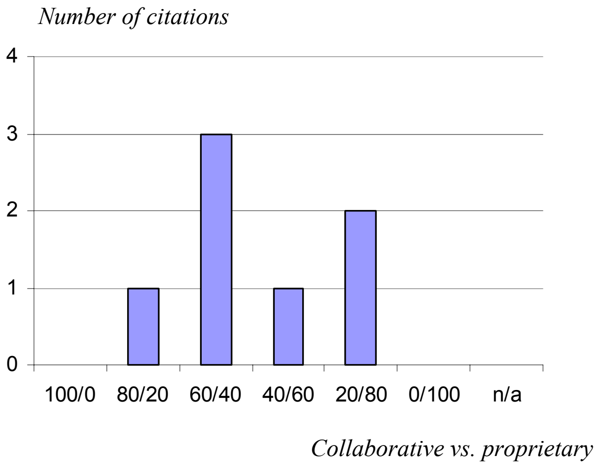


Figure 44: Stockholm knowledge vs. explicit knowledge work

This confirms that R&D here is neither fully exploitative nor fully explorative, driven instead by dual R&D missions. The data furthermore confirms the original notion that tacit knowledge is associated with research and explicit knowledge is associated with development.

4.1.5.7 STOCKHOLM SIZE OF PARTNER NETWORKS

The sizes of partner networks in the Stockholm sample vary considerably. As indicated by Figures 45 and 46, those facilities with larger numbers of key partners also have a larger number of other partners.

Facility	*Size of key partner network*					*n/a*
	0-4	*5-9*	*10-19*	*20-29*	*30+*	
1			■			
2	■					
3	■					
4			■			
5	■					
6						■
7						■

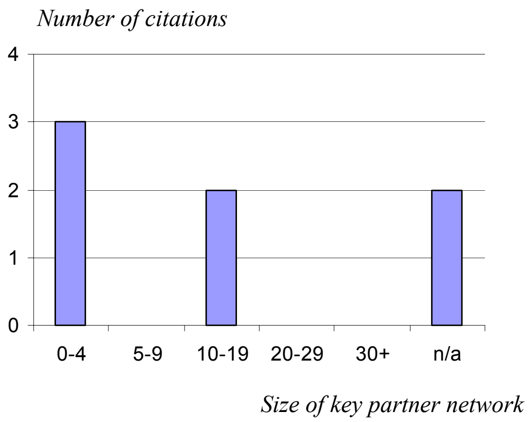


Figure 45: Stockholm size of key partner networks

Facility	*Size of other partner network*					*n/a*
	0-9	*10-19*	*20-49*	*50-99*	*100+*	
1					■	
2			■			
3	■					
4				■		
5	■					
6						■
7						■

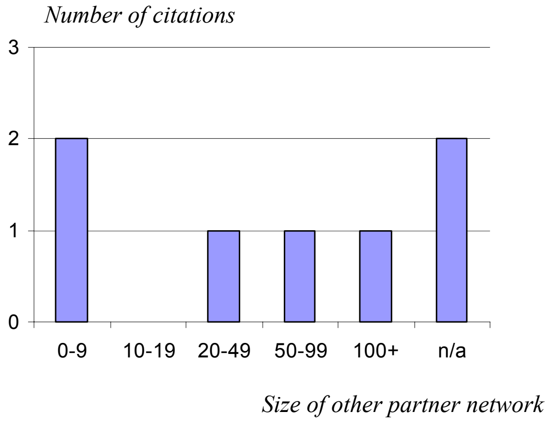


Figure 46: Stockholm size of other partner networks

The other/key partner ratio in the Stockholm sample is 3.81, which is similar to the ratio identified in the Beijing sample. The average other and key partner numbers in Stockholm (42 and 11) were slightly higher than those in Beijing (37.5 and 8.3), indicating that judged purely in terms of the size of their partner networks, the Stockholm and Beijing facilities were similarly collaborative.

The similarity in partner network sizes in Beijing and Stockholm may be explained by similarly exploitative characters of knowledge work at the two locations. In terms of integration behavior in the sense of the MMB model, the partner network sizes, in combination with the closely-knit personal networks characterizing the Stockholm RIS indicate that the network-driven integration process is managed with similar numbers of collaborations partners as the independent firm-based, necessity-driven integration process in Beijing.

4.1.5.8 CONCLUSION: CHARACTERISTICS OF FOREIGN-OWNED R&D IN STOCKHOLM

In summary (see Table 2), foreign-owned R&D facilities in the Stockholm innovation system sample are on average slightly more development- than research-driven, were founded within the last ten years, are fairly small and have been growing at an over average speed. Development- and research-driven facilities in the sample partially follow S&T-driven motives, while the larger part of the sample follow customer company-driven motives. The data shows that in most cases, the RIS did not attract large, full-fledged R&D facilities.

However, the growth of the facilities that did survive the global cuts in R&D spending over the last years proves that foreign-owned R&D in Stockholm is sustainable and thriving slowly. The average character of knowledge work in Stockholm is similar to that of other regions examined, with a very slight tendency towards exploitative, proprietary, and explicit knowledge work. The fact that no clear picture is won from the data is explained by the dual R&D missions of Stockholm facilities. The other/key partner ratio is 3.81 and the facilities are lead mostly by host-country national R&D managers, indicating that while integration behavior differs substantially here from the Beijing sample, key and other network partner sizes as well as the key/other ratio are very similar to those of Beijing-based facilities.

	Foreign-owned facilities in Stockholm
Mission	More development- than research-driven
Motive	1990s: S&T-driven, 2000s: customer company-driven
Behavior	Network-based integration behavior
Age	Mostly less than 10 years
Size	Small
Growth	Over average growth
Character of R&D	Tendency towards exploitative, proprietary, explicit
Other/key partner ratio	3.81 – similar to Beijing
Management nationality	Host country nationals

Table 20: Summary of foreign facility characteristics in Stockholm

The Swedish model is quite different from the Chinese and the UK models. It seems that the key-company centric niche leader typology attributed to the RIS above was mostly a phenomenon of the New Economy years from the early 1990s to about 2001. This insight is supported by the fact that numerous R&D centers that were opened during the boom years were downsized or closed down before March 2004. The phenomenon of changing R&D motives in Stockholm can furthermore be attributed to the fate of Sweden’s telecoms sector, which has been strongly dependent on the fate of Sweden’s largest telecommunications company, Ericsson. With the relative decline in importance of Ericsson, the urban-centric model loses some of its leverage since less spin-outs and less international acquisitions occur, and the transfer factors in the RIS operate at a lesser speed, leading to less new knowledge creation in the RIS. From the perspective of research vs. development, and science and technology- versus market-, or cost-motives driving the internationalization of R&D, Stockholm thus does not present a model as distinct as the other regions covered in this research. This makes Stockholm unique in two senses: (1) the fact that the relative technology monoculture created great volatility for the RIS, and (2) the fact that this is in fact a location mainly for key customer company-driven R&D internationalization.

Implications for policy makers

The Stockholm example shows how important the wellbeing of a single light-house company can be for the dynamic of an entire RIS, especially in the case of small regions focused on a few technologies. Policy makers should thus make sure these lighthouse companies are supported by removing impediments to their international competitiveness. Since Ericsson was the core of the Stockholm RIS in the 1990s, the attractiveness of the entire innovation system to international investors was reduced dramatically when Ericsson got into financial trouble and along with it, the many local supplier and vendor companies that not only depended on Ericsson but also together made up a large part of the Stockholm ICT eco-system.

Greater diversity of industries in an RIS reduces its overall volatility in times of economic turbulence. The logic behind this is similar to the concept of diversification in portfolio theory. In terms of industrial development, policy makers may be faced with a decision on whether to support either a clear industrial focus or industrial diversity in the RIS. Either of the two approaches may be successful, while betting on a single key technology is riskier than driving a diverse portfolio of industries. On the other hand, critical industrial mass is also needed for RIS to attract substantial foreign investment, this being a case for focusing industrial development policy. Diversification however, is also possible (and required) within a selected, single key industry. A diverse population of telecommunications companies is less risky than a single key company that drives and determines a large part of the RIS in this industry.

Sustainability is a key issue in the Stockholm innovation system. While foreign-owned R&D facilities closed down in other RIS around the world since 2000 as well, the situation in the Stockholm RIS seems especially grave. FDI in R&D is an especially volatile form of FDI due to the indirect relationship between R&D and sales revenues on the one hand, and the limited capital investment implied by R&D facilities on the other hand, making it relatively easy to close down or re-centralize such facilities. Policy makers should be aware of this issue and should thus aim towards diversity not only in terms of industry but also in terms of function. The 'Ph.D. monoculture' in the Cambridge RIS (the region hosts almost no manufacturing, marketing, or general management facilities), can be just as much of a threat in turbulent times as the 'industry monoculture' in the Stockholm RIS.

Swedish political entrepreneurship has created lead users (Saperstein and Rouach, 2002) that constituted one of the key attractions of the RIS to foreign companies setting up wireless centers of excellence in Sweden in the 1990s. Entrepreneurial projects of the government included the early and complete privatization of the telecoms sector, government programs subsidizing the purchase of personal computers by private individuals, and far ranging wireless LAN infrastructure programs aimed at integrating the entire society into the information age.

Such lead users made Stockholm attractive as a lead region for technology roadmapping, technology planning, telecommunication services development, product design, and other R&D related activities. When policy makers adopt the view that technology and technology infrastructure is as important to society as electricity and water, they may come to the conclusion that greater efforts geared towards technology adoption by end users may be required, potentially increasing their regions attractiveness as a lead region.

Implications for R&D managers

When considering a foreign R&D investment, parent companies should see that even R&D internationalization may be subject to hype. Thus, care should be taken when following internationalization trends such as the trend in setting up wireless centers of excellence in Stockholm in the late 1990s. After all, sustainability of international R&D investments is not only in the interest of the host region, it is also in the interest of the investing company. Thus, when international R&D investments intend to follow more than mere public relations aims, critical analysis of other companies' R&D location decisions is recommended. Questions to be answered in this context for instance are (1) how sustainable is the attractiveness of the foreign RIS to our company?, (2) how close to our core technology is the knowledge present in the foreign RIS?, and (3) for how long has the foreign RIS been leading in this field of knowledge?

The international openness of the Stockholm RIS has been an important supporting factor in the location decisions of companies setting up R&D here. Such international openness often translates into a proximity of business cultures, which in turn enables parent companies to employ local management without fearing a loss of control while enabling access to tightly-knit personal knowledge networks in the region. This may be one of the reasons why most R&D managers in the Stockholm RIS were of host country (Swedish) nationality. International openness is therefore an important aspect in the foreign R&D location decision.

4.1.6 Characteristics of foreign-owned R&D in Munich, Germany

4.1.6.1 THE MUNICH SAMPLE

The following subsection examines characteristics of foreign-owned R&D facilities in greater Munich and Bavaria (see Table 21). Two of the 16 facilities were located three hours by car to the north of Munich close to the city of Frankfurt. These facilities were included in the sample due to their constant involvement with the Munich RIS. Germany, an industrially decentralized country, hosts numerous industrial clusters that house foreign-owned R&D facilities in ICT and life sciences industries, including greater Frankfurt, Northrhine-Westphalia and the Ruhrgebiet, as well as the Stuttgart/Ulm/Augsburg region. As a result, foreign-owned R&D is dispersed throughout Germany, and each of the RIS are fairly small in international comparison.

	USA/Can.	Japan	Europe	Other	Total
ICT	6	5	2	0	13
Life Sciences	1	0	2	0	3
Other	0	0	0	0	0
Total	7	5	4	0	16

Table 21: The Munich sample

4.1.6.2 R&D MISSIONS IN MUNICH

The R&D missions in Munich, as shown in Figure 47, vary considerably, but on average display a clear tendency towards development.

Facility	*R&D mission*				
	100	*75*	*50*	*25*	*0*
1					■
2				■	
3		■			
4	■				
5	■				
6	■				
7	■				
8					■
9		■			
10				■	
11		■			
12				■	
13		■			
14		■			
15		■			
16		■			

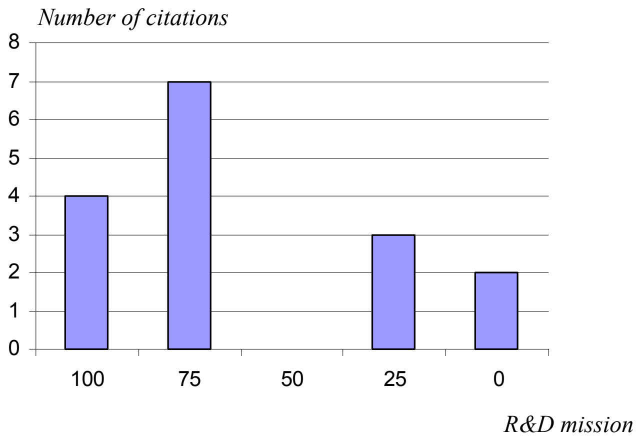


Figure 47: Munich R&D missions

Similar to Cambridge, facilities show a tendency towards pure play research or pure play development. Research-driven facilities in Munich usually collaborate closely with leading local non-university research institutes such as the Max Planck Institut, and/or have sufficient internal resources to constitute full-fledged research facilities. Development-driven facilities typically seek proximity to large customer companies as well as the German consumer market.

4.1.6.3 MUNICH FACILITY AGE

With average ages of 9.3 years at a standard deviation of 9.5 (see Figure 48), the facilities in the Munich sample were relatively young. This young history is linked to the industrial development of Bavaria that started only a few decades ago, as the region was transformed from an agrarian into a technology-driven state. As the industrial development of the region progresses, increasing research and development is locating in the RIS. This distinguishes Munich from Cambridge. While the Cambridge RIS developed around the university, the Munich RIS developed (among other things) around the industry present in the region.

Facility	*Age (years)*			
	1-5	*6-10*	*11-20*	*21+*
1	■			
2	■			
3			■	
4			■	
5				■
6	■			
7				■
8	■			
9		■		
10		■		
11	■			
12	■			
13	■			
14		■		
15	■			
16		■		

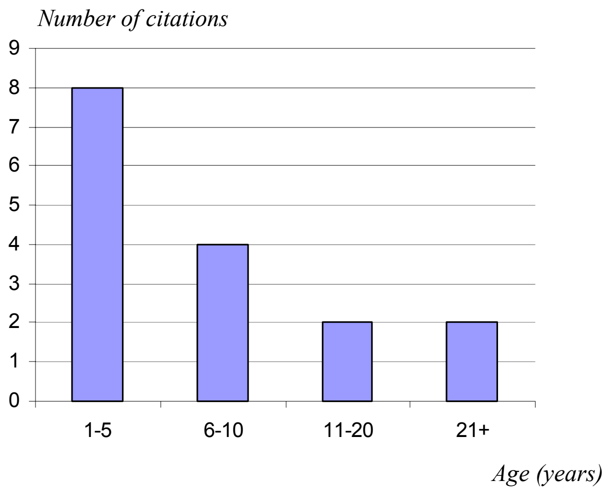


Figure 48: Munich facility ages

The research-driven sites are on average younger than the development-driven sites, indicating that Munich may have been a location of foreign development for a while, whereas it has only begun to attract foreign research over the last ten years. This corresponds with policies of the Bavarian government, lately having stepped up initiatives to attract research to the region. Of the four oldest facilities in the sample, three are strictly development driven, supporting the hypothesis that development in Munich is older than research. The data shows that regional innovation systems can move up the value chain from manufacturing to development to research over time. The data furthermore indicates, in the sense of the MMB model, that the motives driving foreign R&D investment to a certain region can change with time as a result of explicit regional development policy. In the case of Stockholm, international R&D motives changed over time as a result of external economic developments. In Munich, this change was purposefully supported if not even initiated by regional government.

4.1.6.4 MUNICH FACILITY SIZES (MARCH 2004) AND GROWTH

As indicated in Figure 49, the average facility size was 97 R&D employees, with a large standard deviation of 205. The average growth rate p.a. was 5.5 with a standard deviation of 8.7.

Facility	*Size (R&D staff)*			
	1-25	*26-50*	*51-100*	*101+*
1		■		
2		■		
3		■		
4	■			
5			■	
6		■		
7				■
8	■			
9	■			
10			■	
11	■			
12	■			
13	■			
14				■
15		■		
16	■			

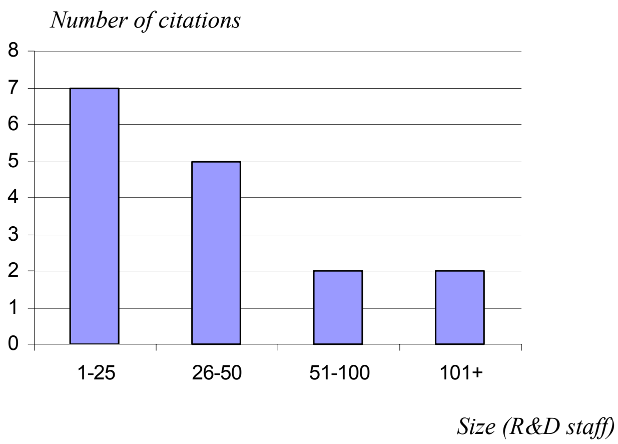


Figure 49: Munich facility size (March 2004)

Roughly one third of the facilities had 25 or less R&D employees, roughly one third had more than 100 R&D employees. The picture is thus very heterogeneous. On average, facilities in Munich are larger than those in Cambridge and Stockholm, but slightly smaller than London and Beijing. Looking at the growth rate of the Munich facilities, the data shows moderate growth, less than Beijing and Stockholm, but more than Cambridge and London. This may be explained by the fact that Munich is in fact a newer location than Cambridge and London, whereas it is neither as new as Stockholm nor as new as Beijing. If indeed the Munich location is developing a new face as a location for pure play research in addition to pure play development, then this would also explain the higher levels of growth.

From the perspective of the MMB model, the regional typology of Munich, the heterogeneity in R&D mission, age, and size, as well as the relatively high growth rates in the Munich RIS indicate foreign-owned facilities with S&T- as well as market-driven motives, as well as facilities tending towards independent firm-based integration behavior and others tending towards network-based integration behavior. In these respects, the Munich RIS proves the most heterogeneous of the regions covered in this research.

4.1.6.5 MUNICH R&D MANAGER NATIONALITIES

The managers in the Munich sample were for the largest part (13 out of 16) of German (host country) nationality. As indicated in Table 22, the managers with home country nationalities were both Japanese. Neither the US nor European facilities employed management with home country nationals. No dual type nationalities were encountered in the Munich sample.

	USA/CAN	Japan	European	Total
Home country national	0	2	0	2
Dual type national	0	0	0	0
Host country national	6	3	4	13
Other	1	0	0	1
Total	7	5	4	16

Table 22: Munich R&D manager nationalities

The large proportion of host country nationals can have two reasons. (1) the German knowledge and innovation environment may be specific, thus *necessitating* local management, and/or (2) proximity in business cultures *enables* foreign corporate headquarters to work with German R&D managers by not fearing a risk of loss control over the local facility. In either case, the local management enables faster integration and access to local knowledge networks, whether or not such access is sought, thus possibly enabling network-based integration behavior for both market- and S&T-driven R&D motives.

4.1.6.6 MUNICH CHARACTER OF KNOWLEDGE WORK

4.1.6.6.1 Explorative versus exploitative aim in Munich

Eleven out of the sixteen facilities (see Figure 50) indicated an exploitative approach to their knowledge work, which once again correlates with the development-driven character of the RIS.

Facility	*Explorative*					*Exploitative*	*n/a*
	100/0	*80/20*	*60/40*	*40/60*	*20/80*	*0/100*	
1	■						
2			■				
3				■			
4			■				
5					■		
6				■			
7					■		
8	■						
9						■	
10				■			
11					■		
12					■		
13					■		
14					■		
15		■					
16				■			

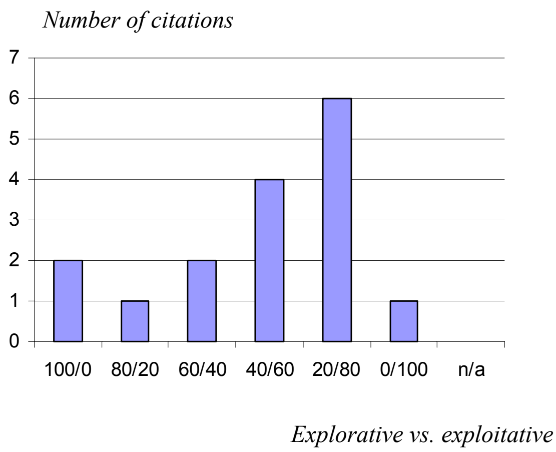


Figure 50: Munich explorative vs. exploitative knowledge work

The five facilities that claimed more explorative work were at the same time the two facilities that claimed research-driven missions. To derive clear conclusions for the entire Munich RIS in terms of the MMB model from this data is difficult due to the heterogeneity of the cluster. However, in terms of the development-driven facilities with exploitative knowledge work, a market-driven motive and independent firm-based integration behavior can be supposed. In terms of the research-driven facilities with explorative knowledge work, as indicated above, S&T-driven R&D motives are supposed, while no indication in terms of integration behavior can be made as of yet.

4.1.6.6.2 Collaborative versus proprietary aim in Munich

The data in Figure 51 does not indicate a tendency towards collaborative or proprietary R&D in the Munich sample.

Facility	Collaborative					Proprietary	n/a
	100/0	80/20	60/40	40/60	20/80	0/100	
1						■	
2				■			
3					■		
4				■			
5		■					
6			■				
7					■		
8		■					
9						■	
10			■				
11	■						
12		■					
13					■		
14				■			
15		■					
16		■					

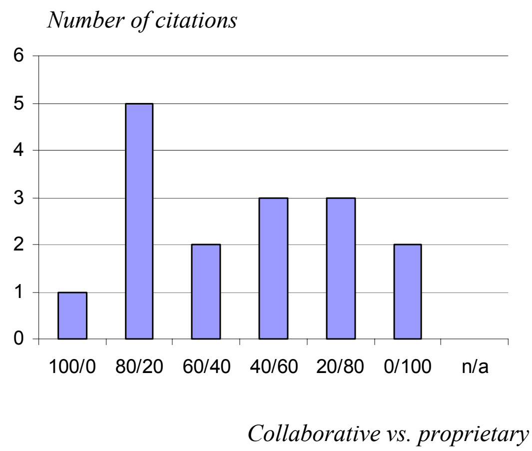


Figure 51: Munich collaborative vs. proprietary knowledge work

It indicates that research and development facilities here can be driven by proprietary and/or collaborative strategies and that there is no clear regional characteristic to be attributed in the Munich case. Thus, no clear indication can be derived for application of the MMB model either. Interestingly however, and for unknown reasons, the region is characterized by more collaborative work than Cambridge or London, both of which tended more towards proprietary work. This possibly indicates network-driven integration behavior on behalf of certain facilities in the Munich RIS.

4.1.6.6.3 Tacit versus explicit knowledge in Munich

The data in Figure 52 does not show any tendency towards tacit or explicit knowledge work. In fact, respondents indicated that their facilities' knowledge work in Munich implied more of a mixture of tacit and explicit knowledge, than facilities in the other location covered.

Facility	*Tacit*					*Explicit*	*n/a*
	100/0	*80/20*	*60/40*	*40/60*	*20/80*	*0/100*	
1						■	
2					■		
3					■		
4			■				
5		■					
6		■					
7			■				
8					■		
9			■				
10		■					
11		■					
12				■			
13			■				
14			■				
15				■			
16				■			

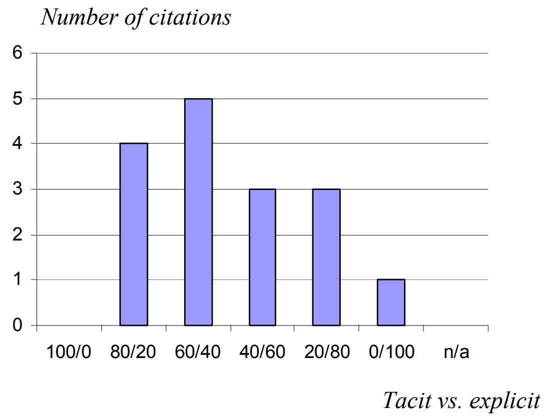


Figure 52: Munich tacit vs. explicit knowledge work

However, the insight gained above that research is more determined by tacit knowledge and development is more determined by explicit knowledge holds even in the Munich in all but four cases. The increasing research activities in the region over the last couple of years has also been mentioned above. Accordingly, the character of R&D in the region can be expected to shift towards the explorative, collaborative, and tacit knowledge-driven end of the spectrum as time progresses.

4.1.6.7 MUNICH SIZE OF PARTNER NETWORKS

As indicated in Figures 53 and 54, the average number of key partners in the Munich sample is 15, the average number of other partners 65. The resulting other/key partner ratio in the sample is 4.3. This ratio is similar to the ratios identified in Beijing and Stockholm, indicating that the relationship between collaboration partner network breadth and depth is similar even in RIS that are very different from one another. Interestingly, the partner ratio size does not vary considerably between facilities of different ages (see also below) as was originally assumed, or between facilities with network-based, and independent firm-based integration behavior.

Facility	*Size of key partner network*					*n/a*
	0-4	*5-9*	*10-19*	*20-29*	*30+*	
1						■
2	■					
3	■					
4		■				
5		■				
6	■					
7	■					
8	■					
9		■				
10			■			
11					■	
12	■					
13	■					
14					■	
15			■			
16		■				

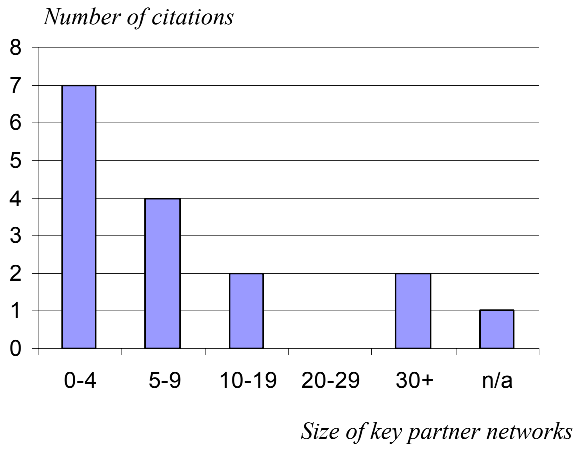


Figure 53: Munich size of key partner networks

Facility	*Size of other partner network*					*n/a*
	0-9	*10-19*	*20-49*	*50-99*	*100+*	
1						■
2		■				
3		■				
4		■				
5			■			
6	■					
7		■				
8	■					
9	■					
10			■			
11					■	
12		■				
13	■					
14					■	
15				■		
16		■				

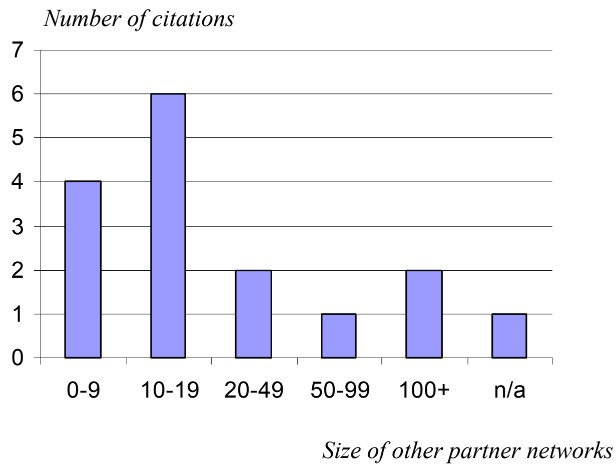


Figure 54: Munich size of other partner networks

4.1.6.8 Conclusion: Characteristics of Foreign-Owned R&D in Munich

The Munich RIS is characterized by a presence of foreign-owned research facilities and development facilities, however with a dominance of development facilities. A summary can be seen in Table 23. Average facility sizes are slightly smaller than those of Beijing and London. Facilities display moderate growth, partner networks sized similarly to those of Beijing and Stockholm, and host country nationality R&D management. R&D here tends slightly towards the exploitative, proprietary and explicit knowledge-driven end of the spectrum. Characterized above as the triple-helix regional typology, the Munich RIS (1) compares to London in that it is driven by a large city in a major European economy, (2) compares to Cambridge in that it is home to leading universities and non-university research, (3) compares to Stockholm in that it hosts large lighthouse companies that attract R&D and drive innovation in the region, and (4) compares to Beijing in that it has a government that plays an important role in the RIS. Diversity is thus the key of the RIS and constitutes one of its key drivers of success for the future, as long as the individual elements of the RIS continue to prosper.

	Foreign-owned facilities in Stockholm
Mission	More development centers than research centers
Motive	Mainly market-driven, also S&T-driven
Behavior	More independent firm-based than network-based integration
Age	Mostly less than 10 years
Size	Large
Growth	Over average growth
Character of R&D	Tendency towards exploitative, proprietary, explicit
Other/key partner ratio	4.3 – similar to Beijing and Stockholm
Management nationality	Host country nationals

Table 23: Summary of foreign facility characteristics in Munich

Implications for policy makers

The Munich RIS is the result of a long-term vision and five decades of consistent implementation of this vision. During the 1990s, numerous regions around the world attempted to create greenfield high-tech clusters, expecting their sustainability if only enough government aid was granted in terms of tax relief and inexpensive office space, all surrounded by an appealing natural landscape. Hardly any of these initiatives succeeded. Even 35 year old Sophia Antipolis, which is considered one of the most successful high-tech parks in Europe, is highly controversial among French and other academics. The planned cross-pollenization between industry, academia, and the arts, seems not to have occurred.

In the Munich RIS, policy makers 'pamper the lighthouse companies', for instance by providing very fast administrative processes such as the granting of building permits. The explicit indication that large foreign companies, if they decide to invest, will be welcomed by such administrative support has been mentioned as extremely helpful by various companies that invested in the Munich RIS. MNC and regional governments may have different perceptions regarding the time that diverse administrative processes should take. Indicating flexibility indicates to the foreign MNC that the region at stake is internationally open, dynamic, and understands the needs of globally operating companies. Such an impressions are important in the R&D location decision process.

The Munich RIS, which includes Bavaria, is aggressively marketed abroad. Invest in Bavaria, the regional marketing agency, has offices in several countries worldwide to market the Bavarian innovation system to MNC. The agency furthermore seeks collaborations with other leading RIS worldwide (such as Cambridge), in order to develop complementarities and to leverage them in mutual benefit. While networks between regions are being established, the government's support of local networks has been stepped down due to a lack of demand for fee-based networking from the industry.

Regardless of the otherwise patient and long term approach to regional development in the region, the Bavarian government massively supported the fast formation of one of Germany's leading biotech parks close to the city of Munich. However, the high speed development of this park has already shown its limits: in the park and the surrounding RIS, the knowledge resources required to turn small companies into big companies are largely missing. Biotech companies thus stay fairly small, so that the park remains more of an incubator rather than a full-fledged industry park hosting world-leading biotech companies. Hence, investment in terms of the setting up of foreign-owned R&D biotech facilities in the park has to date hardly occurred if at all.

Implications for R&D managers

When searching for a location that will remain attractive in the long term as a place for foreign-owned R&D, MNC should consider the diversity of the RIS as a positive factor. The Munich RIS is a good example of such a place (as is London). Especially in regard of new markets emerging at the intersection between existing technologies this diversity pays off in the long term. Furthermore, the combination of an urban center at a central geographic location, providing academic excellence, industrial light-house companies surrounded by supplier companies, and supportive government is a powerful argument in favor of foreign R&D investment decisions.

R&D managers in the Munich RIS furthermore valued the German work ethic, as opposed to Beijing, where R&D managers complained about quality issues and problems with employee loyalty. In fact, quality remains one of the central selling arguments of the Munich RIS, combined with worldwide technology leadership in specific fields that has brought foreign-owned research facilities to the region. The quality aspect of the Munich RIS even caused one foreign pharmaceutical MNC to set up a research facility in Munich among other things to demonstrate solidarity with the location in the face of high costs and pharma-research hostile national legislation. One of the central aspects of regional communications efforts is the quality of life in Bavaria. The quality of life aspect was already of relevance in the Cambridge RIS and it applies to Munich as well. A quiet, safe city with access to many lakes and the nature of the Alps, provides an attractive environment for knowledge workers and will affect the hiring and retaining of top researchers and engineers.

4.1.7 Summary: overview of foreign-owned R&D characteristics

As indicated in Table 24, Cambridge and London were the most research-driven RIS in the sample. The London and Cambridge facilities also had the oldest average ages.

	Average R&D mission	Average facility age
Beijing	63.0	4.8
London	47.9	15.8
Cambridge	47.2	10.6
Stockholm	64.3	5.5
Munich	62.5	9.3

Table 24: Characteristics overview – R&D mission and age

The data indicates that older RIS may indeed be more research-driven than younger RIS. Thus, from the perspective of the MMB model, different facility R&D missions can only be associated with different regional typologies to a very limited extent.

	Average size (March 2004)	Average growth p.a.	Management nationality
Beijing	104.0	21.0	Home/dual
London	140.0	3.1	Host/home
Cambridge	65.2	4.6	Host
Stockholm	58.0	9.5	Host
Munich	97.0	5.5	Host

Table 25: Characteristics overview – Size, growth, and management nationality

Table 25 shows that London and Beijing had the largest facility size averages in the locations covered. However, Beijing and Stockholm had the fastest growing facilities, London the slowest. The manager nationalities are mostly host country, except for Beijing, which also displays dual type nationalities, and London which also displays many home country nationality managers. The R&D manager nationality type seems not only to be a function of host country but also a function of the parent company's home country. Facilities with home country manager nationalities were for the most part of Japanese companies. Due to the control versus integration trade-off in the manager nationality decision, fast growth locations (where control is the priority) are assumed to be more suited for home country nationality management, while slower growing, smaller RIS (where integration is the priority) are more suited for host country nationality management.

As indicated in Table 26, the key/other ratios are similar at each of the locations where data was available. In each of the locations studied, facilities with large key partner networks also had large other partner networks.

	Average key partners	Average other partners	Key/other ratio
Beijing	8.3	37.5	4.5
London	n/a	n/a	n/a
Cambridge	n/a	n/a	n/a
Stockholm	11.0	42.0	3.8
Munich	15.0	65.0	4.3

Table 26: Characteristics overview – size of key and other partner networks, ratio

This homogeneity is surprising taking into account the heterogeneity of the regions and their facilities in other dimensions. The data furthermore shows that the location with the most home country nationality managers (Beijing) also had the smallest key and other partner networks, supporting the assumption of this research that local managers are of prime importance to regional integration. From the perspective of the MMB model, this shows that independent firm-based behavior can be expected to correlate with home country R&D manager nationality, while facilities with host country nationality managers could follow more network-based integration approaches.

The average character of R&D, which can be seen in Table 27, did not vary very much between locations. It did however vary between facilities.

	Explorative/exploitative	Collaborative/proprietary	Tacit/explicit
Beijing	62,7	49,3	56,0
London	60,0	67,3	56,4
Cambridge	53,3	66,7	55,6
Stockholm	62,9	51,4	51,4
Munich	57,5	50,0	50,0

Table 27: Characteristics overview – Character of knowledge work

Concerning the differences that were recorded, Cambridge and Munich had the largest share of explorative activities, Munich and Beijing (interestingly) were the most collaborative, while Munich and Stockholm were the most tacit knowledge-driven.

The analysis of foreign-owned facility characteristics confirmed to a large degree the originally proposed regional typologies. These five typologies were: (1) the government-centric model, (2) the urban-centric model, (3) the university-centric model, (4) the key company-centric model, and (5) the triple-helix model. Independently from this indicator, the regions also varied in terms of their facilities R&D missions and the motives that lead foreign companies to set up R&D there. The motives identified were (1) market-driven, while distinguishing between (a) end user markets, and (b) key customer companies, (2) science and technology-driven, and (3) cost-driven, i.e. low cost of quality R&D personnel. Market-driven models can also be referred to as 'technology-push' models, while science and technology-driven models can be referred to as 'technology-pull' models. Facilities in the regions were also found to vary considerably in terms of their R&D mission. Each region hosted facilities with varying missions, some on average were more development-driven, others were more research-driven. Using these models to describe foreign-owned R&D facilities in different regional contexts enables a deeper understanding of the drivers and realization of the internationalization of R&D.

While this section discussed the characteristics of foreign-owned R&D facilities in the five regions (as of March 2004), the following section will examine the behavior of these facilities as they entered into the respective foreign regional innovation systems. Additional empirical evidence to support the typologies developed above will be presented and discussed.

4.2 Entry behavior of foreign-owned R&D facilities

4.2.1 Introduction

To learn more about the possible links between the regional typologies and the facility models developed above, this part of the research examines foreign-owned R&D facilities' entry behavior into regional innovation systems. The variables used for this analysis are (1) key drivers in the location decision, (2) supporting factors in the location decision, (3) character of the location decision, (4) entry mode, and (5) size at entry.

Location and entry mode decisions are often merely theoretical constructs. In practice, they are not independent from each other and they may not be decision processes with true alternatives at all. For example, foreign R&D facilities may come into existence 'automatically' when foreign companies are acquired. In such a case, there may be no conscious decision to internationalize R&D, there may be no conscious location decision, and there will probably not have been an entry mode decision. In other cases however, location decisions are analytical processes as are entry mode decisions. One of the aims of the following section is to identify where location and entry mode decisions actually take place as opposed to where other factors determine them.

4.2.2 Entry behavior of foreign-owned R&D in Beijing

4.2.2.1 BEIJING ENTRY – KEY DRIVERS OF THE LOCATION DECISION

Respondents were asked about the key drivers that moved the parent company to chose Beijing as a location for the foreign facility. The options were (1) a single scientist, (2) a university institute, (3) a company to acquire, (4) a company to collaborate with, (5) the technology region, (6) the market potential, and (7) the labor market. Each option was to be graded in its importance from 0 (not at all important) to 4 (a key driver). (5)-(7) in the sense of the MMB model, relate to the three motive types, while (1)-(4) reflect different sources of knowledge for the foreign facility. The results are presented in Table 28 below, grey fields indicate when either low or high importance levels were given by at least two thirds of the respondents.

	0	1	2	3	4	n/a	Total
Single scientist	12	2	1	0	1	1	17
University institute	5	3	1	5	2	1	17
Company to acquire	14	1	0	1	0	1	17
Company to collaborate with	8	1	2	1	4	1	17
Technology region	5	4	4	1	2	1	17
Market potential	0	0	1	4	11	1	17
Labor market	2	0	0	5	9	1	17

Table 28: Beijing key drivers of the location decision

The data shows that the foreign-owned R&D facilities in the sample were set up in Beijing mainly to tap into local market potential and the local labor market (15 out of 17 managers attributed high levels of importance to market potential, 14 out of 17 attributed high levels of importance to labor market). Since China has a huge market potential and the Chinese central government, as the gatekeeper to this market is located in Beijing, this data is not surprising. The 1.3 billion inhabitant population also indicates a great labor market potential taking into account the low salary levels of Chinese scientists and engineers, and the fact that Beijing has the highest density of universities in China, while hosting China's leading universities, Tsinghua University and the University of Peking. The drivers that played the least important roles were 'a single scientist' and 'a company to acquire', followed by 'the technology region' and 'a company to collaborate with'. The data furthermore shows that the Beijing innovation system at the time of entry did not host many companies that would have been worth acquiring. The knowledge in the Beijing RIS itself does not play as much of a role as the potential to develop knowledge here to leverage the huge Chinese market: nine out of 17 managers gave 'the technology region' a low level of importance, four gave it medium importance.

4.2.2.2 BEIJING ENTRY – SUPPORTING FACTORS IN THE LOCATION DECISION

R&D facility managers were asked which factors, in addition to the key factors, played a supporting role in the locational decision. The factors and the levels of importance attributed to them (from 0 – not at all important to 4 – very important), are presented in Table 9 below. Once again, grey fields indicate when either low or high importance levels given by at least two thirds of respondents.

Market size and market growth again were the most important supporting factors in the location decisions, followed by proximity to a large labor pool and key customer companies, proximity to existing parent company sales and marketing and/or manufacturing subsidiaries, and strong university research. Other factors played a very small or no role in supporting the location decision.

	0	1	2	3	4	Total
Proximity to large target/lead market	0	1	1	5	10	17
Proximity to strong target/lead market growth	0	1	1	5	10	17
Proximity to strong university research	2	2	2	4	7	17
Proximity to strong state research	3	1	3	5	5	17
Proximity to large scientific labor pool	0	1	2	6	8	17
Presence of key customer companies	2	1	2	6	6	17
Presence of key suppliers/vendor companies	5	3	4	3	2	17
Presence of key complementary technology companies	3	4	7	2	1	17
Presence of key competitor companies	5	3	3	5	1	17
Highly conductive research and innovation environment	2	1	4	4	6	17
Favorable government and administrative environment	2	2	3	7	3	17
Favorable public transport infrastructure (i.e. airports, highways, etc.)	2	4	4	5	2	17
Strong local presence of Parent Company	1	2	1	7	6	17
Strong local presence of other companies from the home country	4	1	8	4	0	17
Strong local presence of other international companies	1	1	7	8	0	17
Strong local experience of the Lab Manager	4	4	3	4	2	17
Cultural proximity to the home country	8	6	3	0	0	17
Government financial incentives	4	4	5	4	0	17
Regional marketing and relocation services	6	2	5	4	0	17

Table 29: Beijing supporting factors in the location decision

This data confirms the original key drivers to enter into China with an R&D facility: market and labor. The importance of proximity to parent companies' existing facilities shows the difficulty of setting up greenfield R&D facilities in a region as culturally distant as Beijing. Setting up a new R&D facility in proximity to existing parent company facilities is referred to as 'add-on' greenfield investment. Such add-ons benefit from parent company administrative and physical infrastructures already in place. The importance of key customer companies is explained by the fact that large, state owned companies, with their headquarters in Beijing, often procure technology for the entire Chinese market or large parts of the Chinese market. Proximity to such companies may increase the chances of becoming their supplier. Neither government financial incentives, nor regional marketing and relocation initiatives played a role, indicating that foreign-owned R&D facilities were not given explicit financial incentives to set up facilities here, neither were they aided to a great extent by the government with the process of setting up. Local supplier/vendor companies and competitor companies were of little importance because Chinese companies still lie behind the Western technological frontier. The indication that cultural proximity did not play a role is trivial.

4.2.2.3 BEIJING ENTRY – SIZE AT FOUNDING

Foreign-owned facilities' size at founding gives insight into the level of commitment companies are willing to make from the start to the regional innovation system. It also demonstrates the level of perceived risk involved with entering into a foreign region. The greater the size at founding, the lesser the perceived risk and the greater the commitment. Figure 55 below shows the initial sizes of the 17 foreign R&D facilities in the Beijing sample.

Facility	*Size at founding (R&D staff)*					
	1-10	*11-20*	*21-30*	*31-40*	*41-50*	*51+*
1	■					
2		■				
3						■
4	■					
5					■	
6	■					
7				■		
8	■					
9			■			
10	■					
11	■					
12	■					
13	■					
14		■				
15		■				
16	■					
17			■			

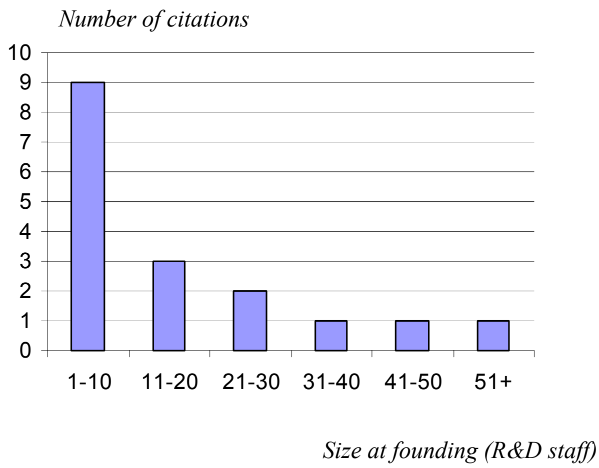


Figure 55: Beijing facility size at founding

The average size at founding in Beijing was 22 R&D employees, with a standard deviation of 24. Nine out of 17 facilities had less than 10 R&D employees at founding, another three had between ten and 20 R&D employees at founding. A 'start small, grow large fast' characterization can thus be attributed to the Beijing facilities taking into account the fast growth rate of the Beijing facilities identified above. From the perspective of the MMB model, the 'start small grow large fast' character of the Beijing facilities can be associated with the cost-, market-, and S&T-driven motives of R&D internationalization, while indicating independent-firm based integration behavior (with home country nationality management) rather than network-based integration behavior.

4.2.2.4 Beijing Entry – Facility Entry Mode

As noted in the theoretical introduction to this work, the research distinguishes between greenfield investments, add-on greenfield investments, acquisitions, joint ventures, and university spin-ins. The mode of entry selected when investing into R&D abroad gives insight into the industrial structure of the RIS, as well as the internationalization behavior of the investing parent companies. Figure 56 shows the entry mode distribution within the sample.

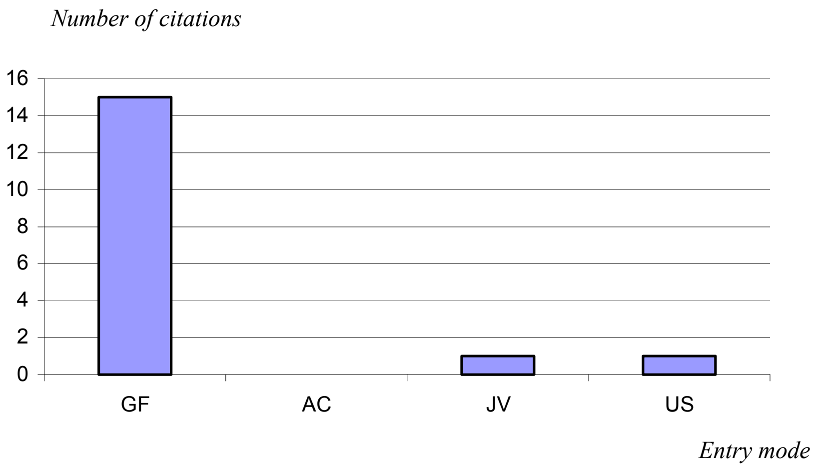


Figure 56: Beijing entry modes

15 out of 17 R&D facilities entered by greenfield investment, none by acquisition, one by joint venture and one by university-spin in. Of the 15 greenfield investments, 7 were add-on investments, made in close proximity to existing sales and marketing or manufacturing operations. Two respondents indicated that the greenfield investment was chosen because there were no companies to acquire at the time, two claimed it was for reasons of controlling intellectual property, two claimed it was the company's culture to do greenfield investments. This indicates that even within the category of one entry mode, several motives for choosing the same entry mode exist, some are region-driven, some are company-driven. It becomes apparent that the entry mode decision, as it is often portrayed in the literature, is in fact often not much of a choice at all, but a dependent variable driven by a host of other company- and

region-specific factors. Almost no use was made of R&D joint ventures, acquisitions, and university spin-ins because intellectual property is difficult to protect in China, and because a lack of scientific and technological expertise makes it difficult to find companies to acquire or universities to collaborate with. This presents further support for independent firm-based integration behavior in the sense of the MMB model, while indicating the importance of the market-driven motive for R&D internationalization to the Beijing RIS.

4.2.2.5 CONCLUSION: ENTRY BEHAVIOR OF FOREIGN-OWNED R&D IN BEIJING

Market potential and the large labor market were the prime reasons foreign companies set up R&D in Beijing. In addition to market size and dynamics, university research and key customer companies served as supporting factors in location decisions. Beijing R&D facilities start out small but grow quickly to reach sizes similar to facilities in London and Munich. Whereas numerous joint ventures are common entry modes for foreign production facilities in China, this is not the case for R&D facilities. Due to the high rates of knowledge attrition and the fact that Chinese knowledge resources in many cases lag behind the technological frontier, joint ventures and acquisitions are less frequent than greenfield entry. However, most of the greenfield facilities are what is considered add-on investment in close proximity to existing corporate structures of the parent company. In terms of the MMB model, the facilities attracted to Beijing come mainly for development purposes and seek market proximity rather than technology proximity.

4.2.3 Entry behavior of foreign owned R&D in London

4.2.3.1 LONDON ENTRY – KEY DRIVERS OF THE LOCATION DECISION

Unfortunately, the amount of non-available data is very high in this regional sample (see Table 30). Nonetheless, the key drivers emerging from the data are ‘technology region’ and ‘market potential’. Single scientists had very little effect on the locational decision, as did the presence of specific university institutes.

	0	1	2	3	4	n/a	Total
Single scientist	6	0	0	1	0	5	12
University institute	5	0	0	2	0	5	12
Company to acquire	4	0	1	0	2	5	12
Company to collaborate with	2	0	1	1	0	8	12
Technology region	0	1	0	5	1	5	12
Market potential	2	0	1	1	3	5	12
Labor market	2	0	0	2	0	8	12

Table 30: London key drivers of location decisions

The picture corresponds with the urban-centric typology of London presented above, primarily offering access to a large market potential in a business and technology friendly environment. Viewed from the perspective of the MMB model, the data shows the market-driven motive for R&D internationalization as well as indications of independent firm-based integration behavior.

4.2.3.2 London entry – supporting factors in the location decision

As indicated in Table 31, the most important supporting factors were the highly conductive research environment and the cultural proximity to the home country, followed by proximity to a large target/lead market.

	0	1	2	3	4	n/a	Total
Proximity to large target/lead market	2	2	0	3	4	1	12
Proximity to strong target/lead market growth	2	2	4	1	2	1	12
Proximity to strong university research	2	3	1	1	4	1	12
Proximity to strong state research	3	3	1	1	2	2	12
Proximity to large scientific labor pool	0	1	6	3	1	1	12
Presence of key customer companies	1	4	1	4	1	1	12
Presence of key suppliers/vendor companies	2	8	1	0	0	1	12
Presence of key compl. technology companies	2	4	4	1	0	1	12
Presence of key competitor companies	5	4	1	1	1	1	13
Highly conductive research and innovation environment	1	2	0	4	4	1	12
Favorable government and administrative environment	2	0	3	3	3	1	12
Favorable public transport infrastructure (i.e. airports, highways, etc.)	3	0	5	0	3	1	12
Strong local presence of Parent Company	4	3	0	2	2	1	12
Strong local presence of other companies from the home country	5	3	2	1	0	1	12
Strong local presence of other international companies	3	6	2	0	0	1	12
Strong local experience of the Lab Manager	3	7	0	0	1	1	12
Cultural proximity to the home country	1	1	1	6	2	1	12
Government financial incentives	5	2	2	1	0	2	12
Regional marketing and relocation services	6	3		0	1	2	12

Table 31: London supporting factors in the location decision

Factors that were of least importance were the strong local experience of the lab's designated manager, the presence of key supplier/vendor companies, proximity to competitor companies, the presence of other international companies, regional marketing and relocation services, and the local presence of other companies from the home country.

Indications on the importance of market size, general research environment, cultural proximity, and administrative environment all correspond with the 'urban center' typology. In this model, the local presence of single partners or research facilities plays less of an important role. The facilities in London are focused on research and development with the aim of pushing their technologies into the market quickly and efficiently. Seen from the perspective of the MMB model, the supporting factors in the location decision indicate both the S&T-driven as well as the market-driven motivations for R&D internationalization. In terms of integration behavior, the fact that none of the sources of knowledge listed were given high levels of importance, once again indicates independent firm-based behavior.

4.2.3.3 LONDON ENTRY – SIZE AT FOUNDING

The size of London-based R&D facilities at the time of their founding varies (see Figure 57), even though the larger part of the facilities (six out of ten) started out with 1-25 R&D employees.

Facility	*Size at founding (R&D staff)*					
	1-25	*26-50*	*51-75*	*76-100*	*101+*	*n/a*
1	■					
2			■			
3	■					
4	■					
5	■					
6		■				
7	■					
8						■
9						■
10					■	
11					■	
12	■					

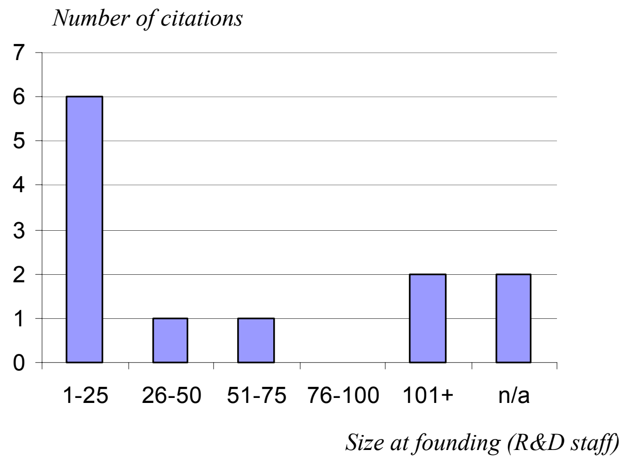


Figure 57: London facility size at founding

The average size at founding was 122 R&D employees with a standard deviation of 250. However, this large standard deviation is explained by the acquisitions in the sample. In acquisition cases, full-fledged R&D departments with many employees are taken over, leading to large size at founding numbers. The heterogeneity in founding sizes across all of the regions covered in this research shows that it is difficult to deduct conclusions from the data generated on this variable.

4.2.3.4 LONDON ENTRY – FACILITY ENTRY MODE

Greenfield and acquisition entry were equally common in London, but there were no joint venture or university spin-in entries, as shown in Figure 58. All of the facilities chose proprietary entry modes, reflecting a need for clear intellectual property ownership. As opposed to Beijing, the London RIS apparently has or had companies worth acquiring by foreign global players.

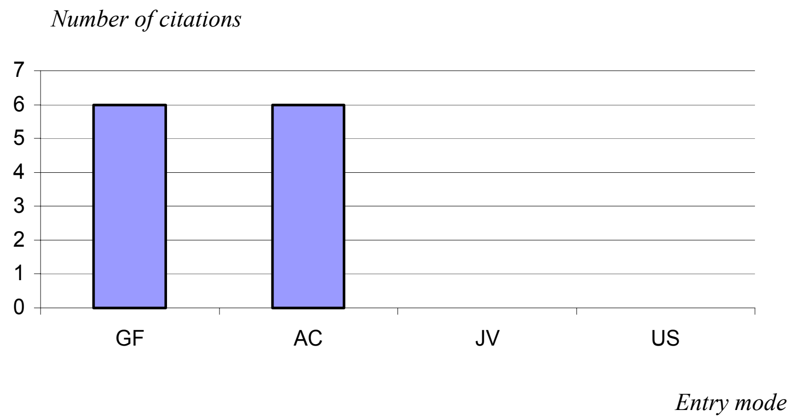


Figure 58: R&D facility entry modes in London

The proprietary ownership entry model implies the wish to conduct a long-term investment within the London RIS, since joint ownership entry models typically demonstrate some sort of test or temporary commitment based on joint ownership and limited financial commitment. Though both the 'make' and the 'buy' entry models were equally present in the London sample, the 'proprietary' entry model emerges as the dominant regional model. This once again shows long term commitment to market- and S&T-driven motives, while at the same time indicating independent firm-based integration behavior.

4.2.3.5 Conclusion: entry behavior of foreign-owned R&D in London

Both the leading character of the technology region as well as the large market potential presented by the European markets were key drivers of location decisions for foreign-owned R&D facilities in this region. The highly conductive research and innovation environment as well as the cultural proximity to foreign companies' home country were important supporting factors in R&D location decisions. London facilities were fairly large at founding, indicating the clear long term commitment international companies make to conduct R&D in the London region. Both greenfield and acquisition entries were common in the London RIS. This can be attributed to the fact that in addition to providing an attractive environment for setting up greenfield facilities, numerous acquisition candidates exist locally, that are bought to establish a regional R&D presence. In terms of the MMB model, the region attracts both research- and development-driven facilities, however, these facilities seek market proximity more so than technology proximity.

4.2.4 Entry behavior of foreign owned R&D in Cambridge

4.2.4.1 CAMBRIDGE ENTRY – KEY DRIVERS OF THE LOCATION DECISION

Due to a lack of sufficient data, the key drivers of the location decisions in Cambridge cannot be discussed in this research. The supporting factors table will be discussed in terms of any implications reflecting key drivers of the location decisions instead.

4.2.4.2 CAMBRIDGE ENTRY – SUPPORTING FACTORS IN THE LOCATION DECISION

The factors that were most important as indicated in Table 32 were (1) proximity to strong university research, (2) proximity to a large scientific labor pool, (3) highly conductive research and development environment. Most other factors were given very little or no importance.

	0	1	2	3	4	n/a	Total
Proximity to large target/lead market	4	2	1	1	1	0	9
Proximity to strong target/lead market growth	3	2	1	2	1	0	9
Proximity to strong university research	0	1	2	1	5	0	9
Proximity to strong state research	2	5	1	1	0	0	9
Proximity to large scientific labor pool	1	0	0	4	4	0	9
Presence of key customer companies	5	0	2	2	0	0	9
Presence of key suppliers/vendor companies	6	1	0	2	0	0	9
Presence of key compl. technology companies	2	1	4	2	0	0	9
Presence of key competitor companies	4	3	1	1	0	0	9
Highly conductive research and innovation environment	0	1	0	1	7	0	9
Favorable government and administrative environment	1	2	1	5	0	0	9
Favorable public transport infrastructure (i.e. airports, highways, etc.)	3	3	2	1	0	0	9
Strong local presence of Parent Company	7	0	1	0	1	0	9
Strong local presence of other companies from the home country	6	3	0	0	0	0	9
Strong local presence of other international companies	4	3	2	0	0	0	9
Strong local experience of the Lab Manager	4	2	0	0	3	0	9
Cultural proximity to the home country	2	2	1	3	1	0	9
Government financial incentives	6	3	0	0	0	0	9
Regional marketing and relocation services	6	2	1	0	0	0	9

Table 32: Cambridge supporting factors in the location decision

These findings correspond well with the Cambridge university-centric regional typology, in which the ‘small is beautiful’ science- and research-driven character of the region is described. The Cambridge RIS is distinctly different from the London RIS in the aspect that university presence was much less important there and market size was much more important. This confirms the market-driven (London) versus science and technology-driven (Cambridge) models described above. It also implies that integration behavior in the sense of the MMB model must be more network-based than independent firm-based since the academic community in Cambridge is very tightly-knit and determined to a large extent by personal networks.

4.2.4.3 CAMBRIDGE ENTRY – SIZE AT FOUNDING

In line with the small company typology of the Cambridge RIS, Figure 59 shows that the foreign-owned R&D facilities covered in this region were smaller at founding (average of

23.6, standard deviation of 33.4) than those in the greater London innovation system (average of 122).

Facility	Facility size (R&D staff)					
	1-10	11-30	31-50	51-70	71+	n/a
1					■	
2	■					
3	■					
4	■					
5			■			
6		■				
7		■				
8	■					
9						■

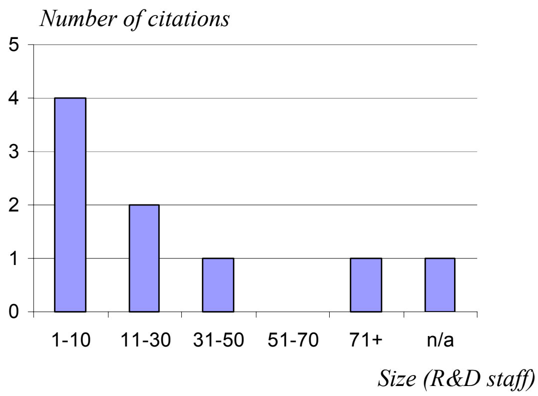


Figure 59: Cambridge facility size at founding

When removing the largest case from the London sample, the average size at founding is 46, which is still considerably higher than that of Cambridge. When comparing Cambridge with Beijing, founding sizes were similar in both cases (Cambridge 23.6, Beijing 22).

4.2.4.4 CAMBRIDGE ENTRY – FACILITY ENTRY MODE

Figure 60 indicates the entry modes chosen to set up foreign-owned R&D facilities in the Cambridge sample. Greenfield investments and acquisitions were equally present in the sample, one facility cited university spin-in as its mode of entry. Joint ventures were not cited.

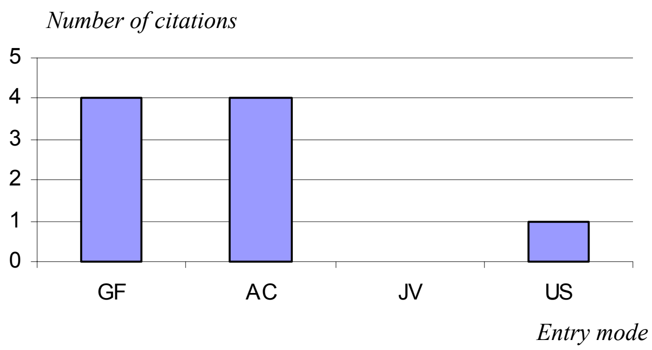


Figure 60: Cambridge entry modes

The R&D acquisitions in Cambridge are a result of numerous University of Cambridge spin-outs that have leading technology but lack the entrepreneurial and management capacities to grow into global companies. The greenfield investments result from companies' specific R&D needs frequently aimed at collaboration with the University of Cambridge.

The data in this and other locations studied shows that development-driven facilities chose acquisitions ('buy') more often than research-driven facilities that tend more towards greenfield investments ('make'). This fact confirms the notion that specific research needs make it difficult to acquire, whereas development needs often require speed to market and thus it necessary to have a team up and running quickly rather than building it on their own. In the case of research-driven greenfield investments in Cambridge, university professors are commonly hired and put in charge of the foreign-owned R&D facilities. In such facilities, they are the driving force of the facility and in effect are as individuals the primary 'raison-d'être' of the facility at the Cambridge location. In this case, hiring top academics to set up a lab can be regarded as 'buying an individual' rather than 'buying a company'. In this particular case, the greenfield investment can thus also be seen as a type of acquisition.

4.2.4.5 CONCLUSION: ENTRY BEHAVIOR OF FOREIGN-OWNED R&D IN CAMBRIDGE

Strong university research, the local scientific labor pool, and a highly conductive research and innovation environment were the main reasons that attracted foreign-owned R&D facilities to Cambridge. Facilities here were rather small at founding, and entered mostly in the form of greenfield investments or acquisitions. In terms of the MMB model, both research- and development-driven facilities entered Cambridge, however they sought technology rather than market proximity.

4.2.5 Entry behavior of foreign owned R&D in Stockholm

4.2.5.1 STOCKHOLM ENTRY – KEY DRIVERS OF THE LOCATION DECISION

The data in Table 33 is very heterogeneous, probably also due to the small size of the sample. In four cases, single scientists played very limited or no roles, in three cases they were key to the location decision.

	0	1	2	3	4	n/a	Total
Single scientist	3	1	0	0	3	0	7
University institute	5	1	1	0	0	0	7
Company to acquire	3	0	1	1	2	0	7
Company to collaborate with	3	0	2	0	0	2	7
Technology region	0	1	3	2	1	0	7
Market potential	0	1	5	1	0	0	7
Labor market	0	3	0	2	0	2	7

Table 33: Stockholm key drivers of location decisions

University institutes played very small or no roles at all. The importance of companies to acquire varies across the sample. Companies to collaborate with were of little or not importance at all. The technology region as ranked between medium to important. Market potential was given medium importance. Two respondents ranked the labor market as important, three ranked it as unimportant.

4.2.5.2 Stockholm Entry – Supporting Factors in the Location Decision

The data in Table 34 is heterogeneous. None of the factors emerge as strong supporting factors. Emerging with medium importance are proximity to a large scientific labor pool and proximity to important customer companies.

	0	1	2	3	4	n/a	Total
Proximity to large target/lead market	2	2	0	2	1	0	7
Proximity to strong target/lead market growth	3	0	2	1	1	0	7
Proximity to strong university research	1	2	1	1	2	0	7
Proximity to strong state research	3	3	0	1	0	0	7
Proximity to large scientific labor pool	0	1	2	2	2	0	7
Presence of key customer companies	0	2	1	1	3	0	7
Presence of key suppliers/vendor companies	3	1	1	2	0	0	7
Presence of key complementary technology companies	2	2	1	1	1	0	7
Presence of key competitor companies	3	3	0	1	0	0	7
Highly conductive research and innovation environment	1	2	2	2	0	0	7
Favorable government and administrative environment	3	2	1	1	0	0	7
Favorable public transport infrastructure (i.e. airports, highways, etc.)	1	3	1	2	0	0	7
Strong local presence of Parent Company	4	0	0	2	1	0	7
Strong local presence of other companies from the home country	3	1	1	2	0	0	7
Strong local presence of other international companies	1	2	1	3	0	0	7
Strong local experience of the Lab Manager	2	1	1	2	1	0	7
Cultural proximity to the home country	0	1	4	2	0	0	7
Government financial incentives	6	1	0	0	0	0	7
Regional marketing and relocation services	3	2	2	0	0	0	7

Table 34: Stockholm supporting factors in the location decision

Emerging as non-important supporting factors in the location decision were (1) proximity to large lead/target market, (2) proximity to state research, (3) proximity to supplier/vendor companies, (4) proximity to key competitors, (5) favorable government and administrative environment, (6) government financial incentives, and (7) regional marketing and relocation services. The facilities identified were small R&D groups that were very development, if not even mostly design and service oriented. For these activities, the knowledge requirements in the foreign RIS are not as extensive as in the case of full-fledged R&D facilities. The data confirms, in the sense of the MMB model, the key customer company-driven R&D internationalization motive.

4.2.5.3 STOCKHOLM ENTRY – FACILITY SIZE AT FOUNDING

The average founding size in Stockholm, as indicated in Figure 61, was 18 R&D employees with a standard deviation of 21. Four of the seven facilities had less than ten R&D employees at founding, making the Stockholm facilities the smallest at founding of the five regions studied.

Facility	*Facility size (R&D staff)*				
	1-5	*6-10*	*11-40*	*41-70*	*71 +*
1					■
2	■				
3			■		
4				■	
5	■				
6		■			
7	■				

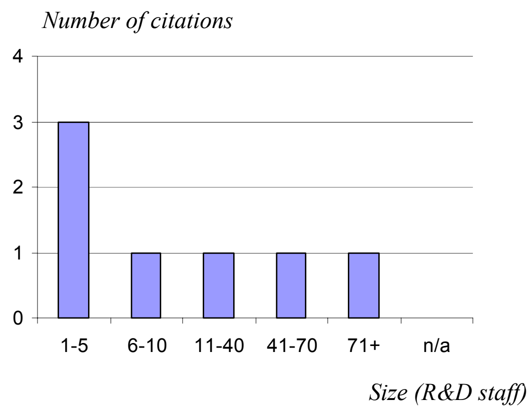


Figure 61: Stockholm facility size at founding

The facility with more than 71 R&D employees was an acquisition. The small founding sizes fit both with the niche leader description attributed to Stockholm in the opening discussion of RIS typologies as well as the key customer company-driven motive for the internationalization of R&D. In view of the S&T-driven motives identified in Stockholm, such technology scanning offices and centers of excellence dealing with newly emerging technologies are usually small. The same goes for R&D groups that locate close to key customers in foreign countries.

4.2.5.4 STOCKHOLM ENTRY – FACILITY ENTRY MODE

As indicated in Figure 62, while greenfield investments and acquisitions were prominent in the Stockholm sample, no joint ventures or university spin-ins were identified.

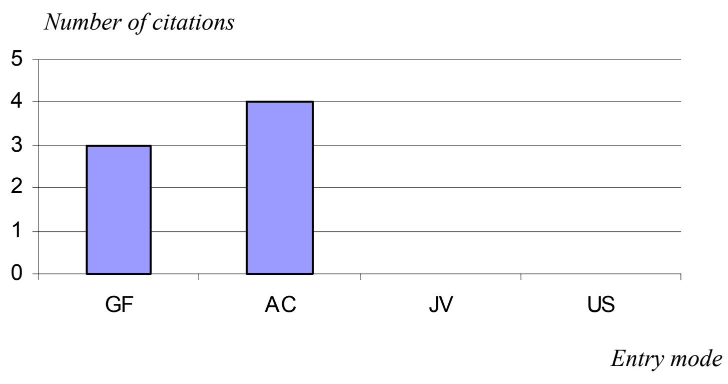


Figure 62: Stockholm entry models

The data supports the notion that the Stockholm RIS is a breeding ground for acquisition candidates, while at the same time acting as a lead market where foreign MNC put up technology scanning and listening post facilities in the form of greenfield investments. In the context of both S&T-driven and key customer company-driven facilities, acquisitions may imply a greater commitment to the region when they imply acquiring entire companies, not just their R&D assets.

The data on the entry behavior of foreign facilities to the Stockholm RIS fits well with the typologies developed earlier. In addition to the key-company centric 'niche leader' typology, dominated by the telecommunications cluster that evolved around Ericsson in the 1990s and leading to S&T-driven R&D internationalization motives, the RIS, in terms of the MMB model, also displays key customer company-driven motives for R&D internationalization. The facilities locating in and around Stockholm mostly have development missions, tending towards design and customer service, especially for the key customer company-driven motives. The entry behavior in Stockholm is furthermore characterized by the volatility of the ICT-driven RIS, based on its relative monoculture around the telecommunications industry. Consequently, R&D motives in the region have shifted with time from S&T- to key customer company-driven.

4.2.5.5 Conclusion: Entry behavior of foreign-owned R&D in Stockholm

No key drivers of significant relevance emerged from the data. In terms of supporting factors, the scientific labor pool and the presence of key customer companies were the most important factors. The Stockholm facilities at founding were among the smallest of all the locations covered. Greenfield investments and acquisitions were the only encountered entry modes. In terms of the MMB model, even though they conducted both research and development in Stockholm, neither market- nor technology proximity seemed to be driving the foreign facilities. Instead, they were attracted by the presence of key customer companies in the region. This may have changed since the 1990s, when many technological centers of excellence were founded in Stockholm to keep abreast of technological developments in the wireless communications industries.

4.2.6 Entry behavior of foreign owned R&D in Munich

4.2.6.1 MUNICH ENTRY – KEY DRIVERS OF THE LOCATION DECISION

As indicated by Table 35, hardly any facility location decisions in the sample were driven by single scientists or by university institutes. The labor market for qualified R&D personnel, the presence of acquisition candidates, or companies to collaborate with did not play much of a role either.

	0	1	2	3	4	n/a	Total
Single scientist	8	5	0	1	1	1	16
University institute	11	2	0	2	0	1	16
Company to acquire	10	1	0	0	4	1	16
Company to collaborate with	10	0	2	1	2	1	16
Technology region	6	1	2	5	1	1	16
Market potential	3	1	1	4	6	1	16
Labor market	9	1	2	3	0	1	16

Table 35: Munich key drivers of R&D location decisions

Seven facilities found that the technology region had no or very little influence on the decision, six found that it had somewhat or a strong influence on the decision. The market potential had the greatest influence on location decisions. Eleven out of fifteen companies attributed a medium to high relevance to this factor in the location decision process. This makes it clear that Munich is, regardless of the increasing foreign research activity going on here, a market-driven development location.

4.2.6.2 MUNICH ENTRY – SUPPORTING FACTORS IN THE LOCATION DECISION

The only factor with a two-thirds share of importance ratings in Table 36 is proximity to large lead/target market. Medium importance ratings were given to (1) proximity to strong university research, (2) highly conductive research and innovation environment, (3) favorable government and administrative environment, and (4) favorable public transport infrastructure. The ratings indicating low importance were (1) proximity to supplier/vendor companies, (2) proximity to the parent company, (3) proximity to other companies from the home country,

(4) local experience of the designated facility manager, (5) cultural proximity to the home country, (6) government financial incentives, and (7) regional relocation and marketing services.

	0	1	2	3	4	n/a	Total
Proximity to large target/lead market	4	1	1	3	7	0	16
Proximity to strong target/lead market growth	3	5	2	4	2	0	16
Proximity to strong university research	2	3	2	4	5	0	16
Proximity to strong state research	4	4	2	4	2	0	16
Proximity to large scientific labor pool	1	6	2	3	4	0	16
Presence of key customer companies	3	6	1	3	3	0	16
Presence of key suppliers/vendor companies	6	6	0	4	0	0	16
Presence of key complementary technology companies	3	4	3	6	0	0	16
Presence of key competitor companies	7	2	3	4	0	0	16
Highly conductive research and innovation environment	1	1	5	5	4	0	16
Favorable government and administrative environment	2	2	6	5	0	1	16
Favorable public transport infrastructure (i.e. airports, highways, etc.)	0	2	5	4	5	0	16
Strong local presence of Parent Company	8	2	1	1	4	0	16
Strong local presence of other companies from the home country	7	4	1	2	1	1	16
Strong local presence of other international companies	3	4	4	4	1	0	16
Strong local experience of the Lab Manager	9	1	3	1	2	0	16
Cultural proximity to the home country	10	1	3	2	0	0	16
Government financial incentives	11	3	0	1	0	1	16
Regional marketing and relocation services	6	5	1	4	0	0	16

Table 36: Munich supporting factors in the R&D location decision

This confirms the original typology on the Munich innovation system, hosting development and research facilities that are mostly market-, and in some cases S&T-driven. The diversity-driven picture associated with the triple-helix model once again becomes apparent. Regardless of the Bavarian government's extensive programs to encourage FDI in R&D, Government financial incentives and regional relocation and marketing services played little or no role in the location decisions. Target/lead market growth and the size of the local labor pool both played a medium role. This contrasts with the Beijing sample, in which labor market and growth were both factors of central importance.

4.2.6.3 MUNICH ENTRY – FACILITY SIZE AT FOUNDING

As indicated in Figure 63, most of the facilities (12 out of 16) were founded with 20 R&D employees or less. In one case, 600 R&D employees were active from the founding year due an acquisition. The average size at founding (excluding the 600 employee facility) is 12 with a standard deviation of 13, which is by far the smallest from the five samples studied. This shows that Munich is a location in which there are few full-fledged stand alone R&D centers, but where R&D is included as an add-on to production, marketing and sales facilities. This finding is distinct from the Stockholm model, where R&D groups were also small, but driven by external key customers instead of internal production, sales, and marketing departments.

Facility	*Size at founding (R&D staff)*					
	1-10	*11-20*	*21-30*	*31-40*	*41-50*	*51+*
1	■					
2					■	
3	■					
4	■					
5		■				
6		■				
7	■					
8	■					
9	■					
10	■					
11	■					
12	■					
13	■					
14						■
15			■			
16				■		

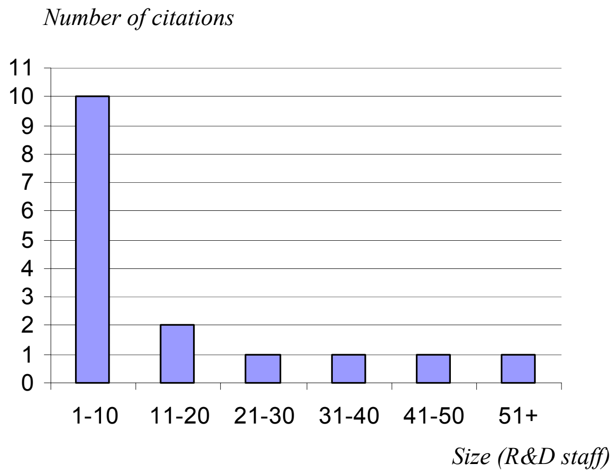


Figure 63: Munich facility size at founding

As opposed to the smaller R&D groups in Stockholm that were externally directed at key customer companies, the smaller R&D groups in Munich were internally directed at supporting production, sales, and marketing activities. Both externally and internally directed R&D takes on a supporting function as opposed to the full-fledged R&D facilities that take on a lead function in global R&D networks. Even full-fledged R&D facilities can be add-ons but must not be, while smaller R&D groups are most often add-ons (Figure 64).

Full-fledged R&D facilities		Small scale R&D groups	
Research-focused	Development-focused	Key customer-focused	Internal department-focused
Lead function		Support function	
Mostly greenfields or acquisitions		Mostly add-ons	

Figure 64: Full-fledged R&D facilities versus small scale R&D groups

4.2.6.4 MUNICH ENTRY – FACILITY ENTRY MODE

Figure 65 shows that greenfield and acquisition entry was prominent in the Munich sample. Of the ten greenfield entries, four were add-on investments. Only one joint venture was recorded in the Munich sample, whereas there were no university spin-ins.

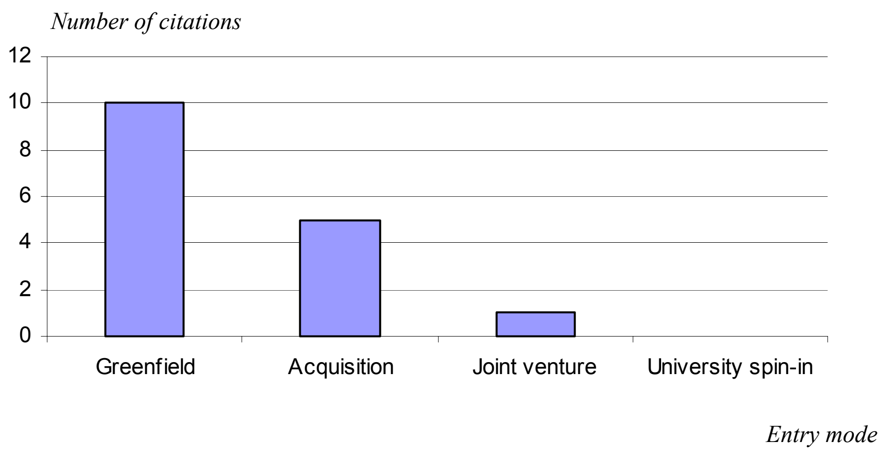


Figure 65: Munich entry modes

The facilities with add-on entry had the smallest number of R&D employees at founding, followed by stand-alone greenfield investments, and acquisitions. In addition to the internally directed R&D groups in the sample, the Munich RIS also hosts full-fledged R&D centers and large R&D groups with global product mandates. These are the stand-alone greenfield, acquisition, and joint venture cases of the sample. The internally directed R&D groups were all founded through greenfield add-on entry.

4.2.6.5 CONCLUSION: ENTRY BEHAVIOR OF FOREIGN-OWNED R&D IN MUNICH

The only key factor emerging in the location decisions is market potential. This is backed up by the examination of supporting factors in the location decision, indicating once again proximity to the large target/lead market. Munich facilities were the smallest of all compared to those in the other regions, indicating the add-on, or support function played by facilities here as opposed to being full-fledged R&D facilities. The dominating share of greenfield investments in this region confirm the add-on theory as a main characteristic of foreign-owned R&D in Munich. In terms of the MMB model, both research and development cause entry, but with a clear focus on market proximity.

4.2.7 Summary: overview of foreign-owned R&D entry

The key and supporting drivers of location decisions varied considerably across the regions, supporting the original typologies while generating some additional insight as well (Table 37). The foreign-owned R&D landscape in each of the RIS is complex, but dominant models nonetheless emerge.

	Beijing	**London**	**Cambridge**	**Stockholm**	**Munich**
Key drivers	*Market potential* *Labor market*	*Market potential* *Technology region*	*n/a*	*No clearly emerging key drivers*	*Market potential*
Supporting factors	*Market size and growth* *University research* *Labor pool* *Key customer companies* *Presence of parent company*	*Research and innovation environment* *Cultural proximity to the home country*	*University research* *Scientific labor pool* *Research and innovation environment*	*Scientific labor pool* *Key customer companies*	*Market potential*

Table 37: Overview of key and supporting drivers of location decisions

Beijing hosts mainly development, market- and cost-driven facilities. London hosts mainly research and development facilities that are market-driven. Cambridge hosts mainly research and development type facilities that are science and technology-driven. Stockholm hosts numerous development, design and customer service-driven facilities that are market- and more specifically key customer-driven, while there are some S&T-driven motives as well. Finally, Munich hosts mainly development and research facilities that are internal-department-driven, as well as a small number of full-fledged R&D facilities. A comparison of the average sizes at founding in the regions (Table 38) lends further support to the typologies.

	Beijing	London	Cambridge	Stockholm	Munich
Size at entry	22.0	46.0	23.6	18.0	12.0

Table 38: Overview of facility founding sizes

For Stockholm and Munich, the founding sizes confirm the small R&D group character. The fact that Stockholm and Munich had the smallest founding sizes as well as small facilities in 2004 also confirms the notion that the roles mid- to long-term played by foreign R&D facilities in a region can already be inferred by examining their size at entry. Below, Table 39 examines regional comparisons of entry modes.

	Beijing		London		Cambridge		Stockholm		Munich	
GF	15	88%	6	50%	4	44%	3	43%	10	63%
AC	0	-	6	50%	4	44%	4	57%	5	31%
JV	1	6%	0	-	0	-	0	-	1	6%
US	1	6%	0	-	1	11%	0	-	0	-
Total	*17*	*100%*	*12*	*100%*	*9*	*100%*	*7*	*100%*	*16*	*100%*

Table 39: Overview of facility entry modes

While greenfield investments overall present the most common entry mode, the two UK locations and Stockholm are characterized by substantial acquisition entry as well, indicating their ability to produce technology companies to be acquired by global players. Joint ventures and university spin-ins were more or less neglected. Foreign R&D thus remains a largely proprietary phenomenon since greenfield and acquisition entry are both proprietary (as opposed to joint) entry modes. These findings once again correspond with the regional typologies. The young age of the Beijing RIS is the reason why MNC find nothing to acquire here. The market-driven, proprietary character of London and Cambridge facilities is the reason for proprietary entry modes, while the age of the RIS enables acquisitions. The key company-centric breeding ground for innovative companies makes the Stockholm RIS attractive for acquisitions, while the market-driven, design- and service-oriented R&D in the region leads to neglect joint ventures and university spin-ins. The market- and S&T-driven character of facilities in diversity-driven Munich enabled both greenfield and acquisition entry.

4.3 Integration behavior of foreign-owned R&D facilities

4.3.1 Introduction

The previous passages discussed the different characteristics of foreign-owned R&D facilities at different locations around the world, as well as differences in the entry behavior of these facilities. The upcoming analyses examine how the foreign owned facilities, once they are present in the RIS, integrate with the RIS by interacting with local knowledge carriers and networks. Insight will be gained especially to gain an understanding of the integration behavior element of the MMB model.

As described above, a diverse population of individuals, organizations, and institutions as knowledge carriers can act as interfaces to the regionally bound knowledge, allowing for the transfer of knowledge between the CIS and the RIS. When compatibility between the two systems is given, these interfaces are used to leverage the regional knowledge to its full extent to optimally fulfill the foreign R&D mission. Thus, after the right location and the right entry parameters are selected, the right integration parameters need to be selected and the models for their use need to be implemented.

As indicated above, the two generic models used to describe the integration behavior, based on Saxenian (1994), are (1) network based integration behavior, and (2) independent firm based integration behavior. The following observations examine (1) the external collaboration partners used, (2) the importance attributed to the different collaboration partners, (3) the physical distance between the foreign facilities and their partners (in those regions where sufficient data could be collected), and (4) the internal and external networks used to contact and access the partners.

The analysis will on the one hand show that integration behavior varies as a function of region and facility type. On the other hand, it will show that the relevance of physical proximity is similar across the regions: In all five regions, proximity for R&D collaborations was only of a limited importance, indicating that proximity-driven spill-over are of a limited importance to international R&D. In numerous cases, the most important collaboration partners for the R&D facilities were not even located within the same country. Furthermore, the data shows that third party networks, such as industry networks or government-driven technology platforms play a much weaker role for the regional integration of foreign R&D facilities than previously thought. By far the most important networks driving integration were the personal networks of the R&D facility management and of its R&D staff.

4.3.2 Integration behavior of foreign owned R&D in Beijing

Regional integration in Beijing depends heavily on access to personal networks, so called 'guanxi'. Day to day work relations in China are very much based on interpersonal trust, indicating the importance of embedded business relationships (see Granovetter, 1985; Uzzi, 1997). Due to the cultural specificity of the Chinese innovation system, integration plays a critical role.

4.3.2.1 BEIJING INTEGRATION – IMPORTANCE OF COLLABORATION PARTNERS

	0	1	2	3	4	n/a	Total
Universities	2	1	3	3	6	2	17
State research labs	2	2	3	3	5	2	17
Customer companies	5	0	2	5	4	1	17
Supplier companies	7	2	2	3	2	1	17
Complementary companies	5	2	2	4	3	1	17
Competitor companies	11	1	4	0	0	1	17

Table 40: Beijing importance of collaboration partners

Table 40 shows that universities and key customer companies were the most important collaboration partners in the sample. Supplier companies and competitor companies were of least importance. This insight fits well with the market- and cost-driven motives associated with the Beijing RIS, since universities give access to future low cost R&D employees and customer companies (typically state-owned) give access to the large Chinese market. Suppliers in ICT and life sciences industries are usually located in countries other than China. Competitor collaborations are avoided due to the already high attrition of proprietary knowledge in the imitation-driven Chinese innovation environment. Collaborating with the competition is automatically implied when conducting almost any type of R&D collaboration in China, so that explicit collaboration with competitors is avoided as far as possible.

The six histograms in Figure 66 indicate the number of respondents that gave the collaboration partner types different importance ratings, 4 indicating critical importance, and 0 indicating irrelevance as collaboration partners. They show a dominance of universities, state research institutes, and customer companies as external collaboration partners. All three of these partners are in fact state partners, aiming to team up with Western companies to learn from them, but also to jointly devise technological solutions specifically for Chinese markets. Furthermore, academic and political career paths are often related, implying that strong personal networks connect universities with the central government. The university can thus be leveraged as a promoter to gain access to the deciding individuals (gate keepers) within central government.

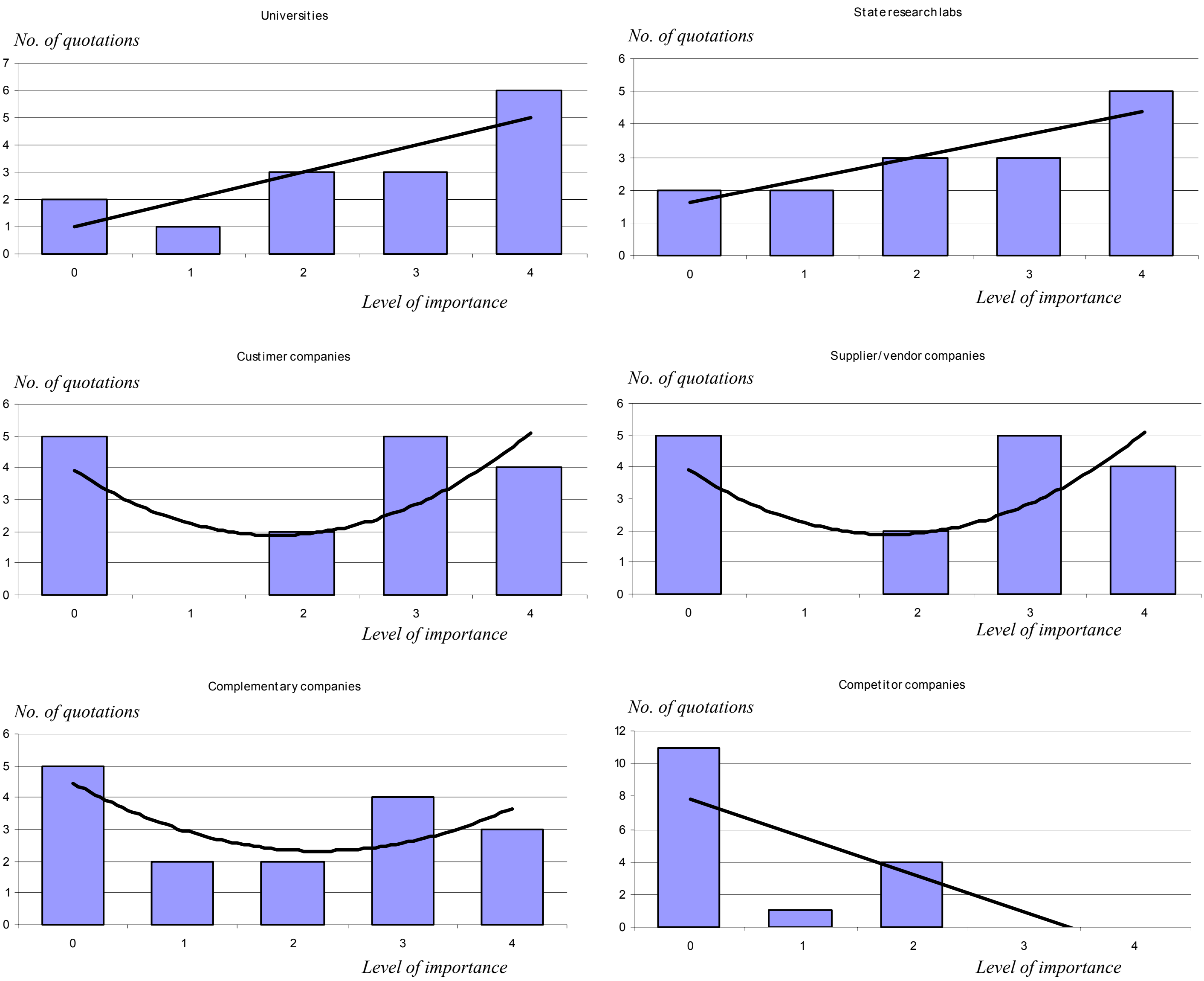


Figure 66: Beijing importance of external collaboration partners

Adding trendlines to the histograms indicates three different types of collaboration partner relevance: (1) important collaboration partners are indicated by linear trendlines with a positive slope, (2) unimportant collaboration partners are indicated by linear trendlines with a negative slope, and (3) partners of medium average importance or partners that were found important by some facilities but unimportant by others are indicated by u-shaped curves indicated by polynominal trendlines. The trendlines confirm that foreign-owned R&D locates in Beijing to gain access to the market and recruit inexpensive, high potential R&D personnel, not to benefit from knowledge-spillovers with suppliers or complementors. Thus, in terms of the MMB model, the data supports the original presumption that integration behavior in Beijing is mainly of independent firm-based nature.

4.3.2.2 BEIJING INTEGRATION – PHYSICAL DISTANCE FROM EXTERNAL PARTNERS

Respondents indicated how far away from R&D facilities collaboration partners are located in terms of hours of driving distance. The results are presented in Table 41. A grade of importance for collaboration partners located in each of the following radiuses was given by respondents: (1) less than 0.5 hour distance, (2) 0.5-2 hour distance, (3) more than 2 hour distance within the host country, and (4) outside the host country. The results are shown in the following table. Grey field in the far right column of the table indicate the two most prominent radiuses for each collaboration partner type.

Universities	0	1	2	3	4	n/a	Total	Score
less 0.5	4	0	1	2	6	4	17	**32**
0.5-2	3	2	1	3	4	4	17	**29**
more 2	1	0	5	5	3	3	17	**37**
outside country	5	2	2	2	2	4	17	**20**
State research labs	**0**	**1**	**2**	**3**	**4**	**n/a**	**Total**	**Score**
less 0.5	4	1	1	3	5	3	17	**32**
0.5-2	5	0	2	2	5	3	17	**30**
more 2	7	2	1	3	1	3	17	**17**
Outside country	12	0	2	0	0	3	17	**4**
Lead customer co's	**0**	**1**	**2**	**3**	**4**	**n/a**	**Total**	**Score**
less 0.5	3	1	1	3	3	6	17	**24**
0.5-2	0	1	5	3	2	6	17	**28**
more 2	0	3	5	0	4	5	17	**29**
Outside country	6	1	3	0	1	6	17	**11**
Suppliers/vendors	**0**	**1**	**2**	**3**	**4**	**n/a**	**Total**	**Score**
less 0.5	7	2	2	3	2	1	17	**23**
0.5-2	2	1	3	3	1	7	17	**20**
more 2	2	1	1	6	0	7	17	**21**
Outside country	0	1	5	3	1	7	17	**24**
Compl. tech. co's.	**0**	**1**	**2**	**3**	**4**	**n/a**	**Total**	**Score**
less 0.5	4	0	3	3	1	6	17	**19**
0.5-2	2	1	1	4	3	6	17	**27**
more 2	2	3	5	0	1	6	17	**17**
Outside country	6	2	1	2	0	6	17	**10**

Table 41: The importance of proximity to collaboration partners in Beijing

Insufficient data was available to learn about competitor collaborations, whereas these are expected minimal regardless of radius due to the nature of the Beijing RIS. The last column shows the overall radius score for each collaboration partner type, calculated by multiplying each grade with the amount of times it was given and then adding up the results. Universities outside Beijing played a more important role than universities within 0.5 hours' driving distance, whereas state research lab collaborations occurred merely within the 2 hour driving radius of greater Beijing. Lead customer company collaborations did not depend on proximity either, the more than 2 hour radius being the strongest here, while a more or less equal distribution of supplier/vendor collaborations becomes apparent throughout the sample. Complementary technology company collaborations for the most part went on within the confines of Beijing. None of the collaboration partner types indicate a clear necessity for physical proximity.

The apparent irrelevance of physical proximity can be attributed to the market- and cost-driven motives followed by most foreign-owned R&D facilities in this sample. In this R&D typology, collaborations are formalized and defined, enabling cooperation over larger distances. The end of this section presents a table with an overview of integration behavior as seen from the perspective of market and cost, versus science and technology driven R&D. The data confirms the independent firm-based characterization of Beijing integration behavior.

4.3.2.3 BEIJING INTEGRATION – USE OF NETWORKS

4.3.2.3.1 Internal networks in Beijing

Table 42 shows that manager personal networks and R&D employee personal networks are by far the most important to facilities to enable regional integration in the Beijing RIS.

Internal networks	0	1	2	3	4	n/a	Total	Score
Mgr personal	1	2	0	6	7	1	17	48
Empl. personal	1	1	1	6	7	1	17	49
Lab HR	7	6	2	1	0	1	17	13
Lab PR	6	4	3	3	0	1	17	19
Home country mgr personal	1	3	5	4	3	1	17	37
Host country non-R&D mgr	2	4	2	7	1	1	17	33

Table 42: Beijing importance of internal networks

Human resources and public relations departments play much less of a role, while home country based managers and host country based non-R&D managers are of medium importance.

4.3.2.3.2 External networks in Beijing

External networks, as indicated in Table 43, were of much less importance than the internal networks examined above.

External networks	0	1	2	3	4	n/a	Total	Score
Consultant	3	4	9	0	0	1	17	22
Gov. matchmaking	4	3	2	6	1	1	17	29
Headhunter	9	3	3	1	0	1	17	12
PR firm	7	7	2	0	0	1	17	11
Ad agency	11	4	1	0	0	1	17	6

Table 43: Beijing importance of external networks

Among the external networks, government matchmaking services and consultant services played the most important roles in enabling the integration with the regional innovation system. External advertising agencies and public relations firms played a very minor role, whereas headhunters played a slightly larger role.

4.3.2.3.3 Networking platforms in Beijing

Networking platforms, as indicated in Table 44, play a role in the Beijing sample, even if this role is not as pronounced as that of the important internal networks.

Networking platforms	0	1	2	3	4	n/a	Total	Score
Industrial club networks	4	2	3	7	0	1	17	29
Non-industrial club networks	8	4	3	1	0	1	17	13
Open industrial networks	3	1	4	6	2	1	17	35
Open non-industrial networks	7	2	3	3	1	1	17	21

Table 44: Beijing importance of networking platforms

Open industrial networks (industrial networks that do not require fee-based membership to participate) and industrial club networks (industrial networks that require fee-based membership to participate) played leading roles here. Non-industrial networks, which are for the most part academic networks, were not as important.

4.3.2.4 Conclusion: Integration behavior in Beijing

Customer companies, universities, and state research labs are the most important collaboration partners to foreign facilities in the sample. However, the physical distance from these collaboration partners does not play much of a role. Manager and R&D employee personal networks are of central importance to access and integrate the knowledge from these collaborations, followed by consultant and government matchmaking networks, open industrial networks, and industrial club networks. The integration behavior of facilities in the Beijing sample is of the 'independent firm based' type, formalized and planned, not driven by horizontal collaboration or ad hoc innovation.

4.3.3 Integration behavior of foreign owned R&D in London

Since most facilities' parent companies have been present in greater London for many years, integration may not be as much of an issue here as it may be in newer innovation systems such as Beijing. Due to the market-driven environment, less collaboration and integration support coming from government organizations or institutions can be expected than in Beijing. Furthermore, due to the established position that London facilities take on due to their age and the mature and business-friendly R&D environment, networking platforms here may, even if they are more mature and professionalized, be less needed than in developing environments such as the Beijing innovation system.

4.3.3.1 London integration – importance of collaboration partners

As shown in Table 45, universities played the most important role as collaboration partners for foreign-owned R&D facilities in the London sample.

	0	1	2	3	4	n/a	Total	Score
Universities	0	2	1	1	7	1	12	35
State research labs	4	1	0	2	4	1	12	23
Customer companies	2	2	3	0	4	1	12	24
Supplier companies	4	2	1	4	0	1	12	16
Complementary companies	1	2	4	3	1	1	12	23
Competitor companies	4	2	3	2	0	1	12	14

Table 45: London importance of collaboration partners

At first sight this seems to contradict the notion that London is a market-driven R&D location. However, many of the facilities view universities as collaboration partners not for joint research, but as providers of human resources. Facilities host interns, Ph.D. students, and other academic researchers and keep direct links with placement offices at universities for recruitment. Thus, a distinction between research- and recruitment-driven university collaborations must be made. State research lab collaborations were important for one group but not important for another group of facilities. Overall, the medium to low importance of most of the collaboration partner types indicate that the foreign-owned R&D facilities in the London sample display independent firm-based integration behavior. The relative heterogeneity of the integration behavior regarding collaboration partners in the London sample is indicated by the following histograms and trendlines in Figure 67:

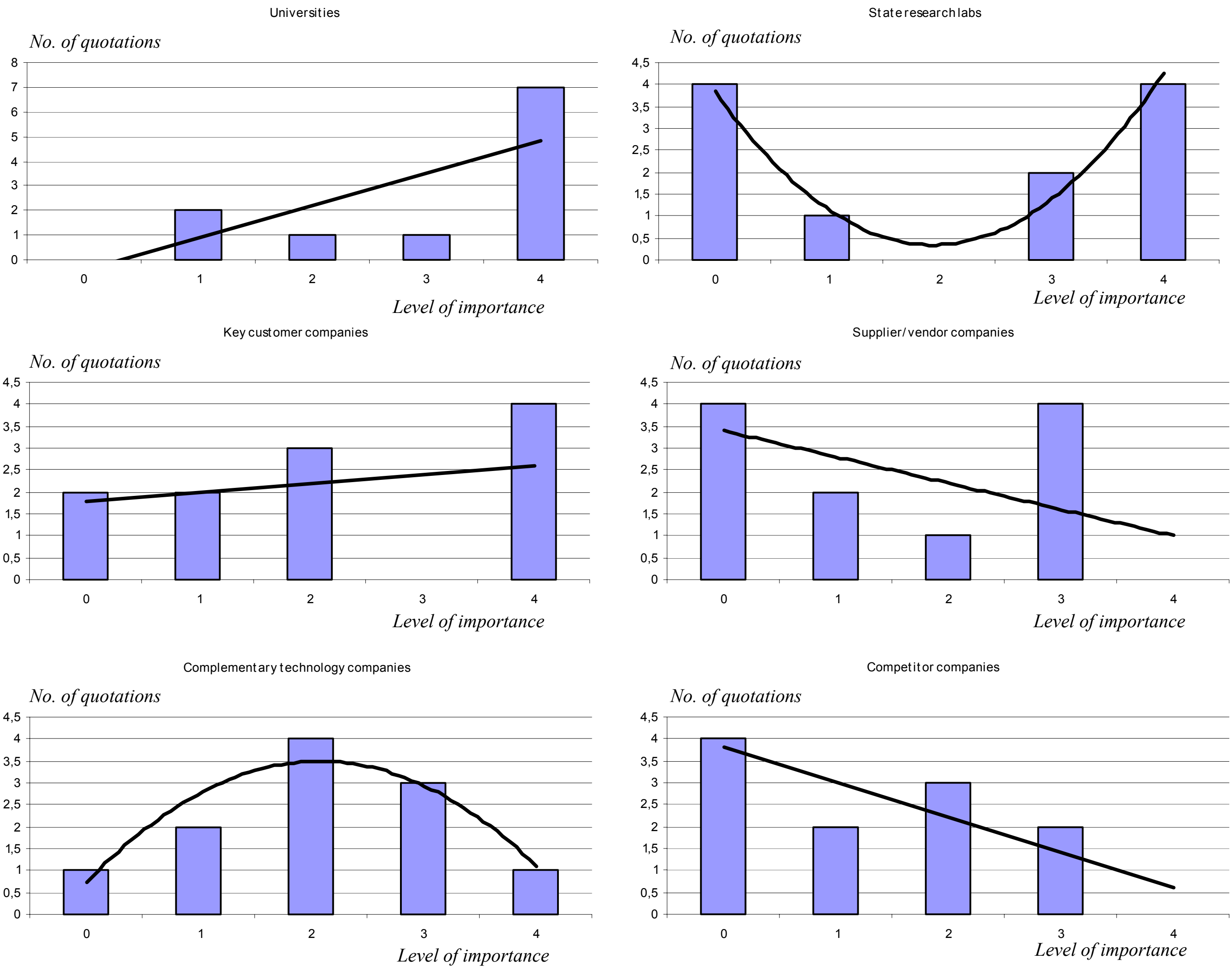


Figure 67: London importance of collaboration partners

4.3.3.2 LONDON INTEGRATION – PHYSICAL DISTANCE FROM EXTERNAL PARTNERS

Due to insufficient data from the London sample, the physical distance of collaboration partners from London facilities cannot be discussed in this research.

4.3.3.3 LONDON INTEGRATION – USE OF NETWORKS

4.3.3.3.1 Internal networks in London

As indicated by Table 46, the facility manager and R&D employee personal networks were by far the most important.

Internal networks	0	1	2	3	4	n/a	Total	Score
Mgr personal	0	1	1	5	4	1	12	34
Empl. personal	0	0	0	5	6	1	12	39
Lab HR	6	3	2	0	0	1	12	7
Lab PR	7	1	1	2	0	1	12	9
Home country mgr personal	2	4	0	5	0	1	12	19
Host country non-R&D mgr	3	3	1	4	0	1	12	17

Table 46: London importance of internal networks

Home country-based managers and host country based non-R&D managers played much less of a role, while human resources and public relations departments played the least important role. The only two internal network types that received any very important ratings at all were the facility manager and the R&D employee personal networks.

4.3.3.3.2 External networks in London

External networks, shown in Table 47, were much less important to the facilities in London than the key internal networks, confirming the original notion of this research. The two top ranking categories, consultant networks and government matchmaking networks scored less than half the points that the two top internal networks above did.

External networks	0	1	2	3	4	n/a	Total	Score
Consultant	3	5	1	2	0	1	12	13
Gov. matchmaking	3	4	3	1	0	1	12	13
Headhunter	5	2	2	2	0	1	12	12
PR firm	8	0	2	1	0	1	12	7
Ad agency	8	1	2	0	0	1	12	5

Table 47: London importance of external networks

Even though headhunters were used, none of the respondents indicated that their role was very important, whereas almost half the interviewees indicated that they were not important at all. External public relations and advertising agencies had hardly any relevance.

4.3.3.3.3 Networking platforms in London

To London facilities, indicated in Table 48, networking platforms were more important than the external networks.

Networking platforms	0	1	2	3	4	n/a	Total	Score
Industrial club networks	1	2	2	6	0	1	12	24
Non-industrial club networks	6	4	0	0	1	1	12	8
Open industrial networks	1	2	5	1	2	1	12	23
Open non-industrial networks	5	4	0	1	1	1	12	11

Table 48: The importance of networking platforms in London

Industrial club networks and open industrial networks played the most important roles. In the London RIS, these networks are expected to be mature and well organized, offering a concrete benefit to members and/or participants. This is not the case in Beijing, where industrial organizations such as associations are less mature and less culturally open to foreign players. Non-industrial networks were not important, indicating that when external networking platforms are employed, they are approached with a clear and industry specific objective. Explorative, inter-industry or academic networking in London thus did not play as much of a role as clearly focused intra-industry networking.

4.3.3.4 CONCLUSION: INTEGRATION BEHAVIOR IN LONDON

In conclusion, integration in the London sample is characterized by independent firm-based behavior, while university collaborations are determined by human resources- rather than research-driven cooperation. The choice of collaboration partners confirms the market-driven motivation assumed to attract international R&D location to this RIS. Universities and key customer companies were the most important collaboration partners, while in terms of internal networks, manager and employee personal networks were of greatest importance. External networks were not important, while in terms of networking platforms, industrial club and open networks were the most important.

4.3.4 Integration behavior of foreign owned R&D in Cambridge

Cambridge, the university-centered 'small is beautiful' regional innovation system, is the smallest and the most focused of the locations covered in this study. Most regional integration activity is expected to involve or in some way be directed towards the University, its service offices, its academics, or its spin-out companies. Due to the importance of personal networks, personal initiative, and independence among Cambridge academics and entrepreneurs (Saperstein and Rouach, 2002), external networks and networking platforms are expected to play even less of a role than they did in London. Therefore, networking for the purpose of regional integration in Cambridge is expected to be ad hoc and physical proximity-driven, so that fewer networking institutions and most definitely less government-driven integration initiatives can be expected. Overall, integration in Cambridge is expected to be characterized by more network-based behavior, which is more horizontally spread out, more ad hoc, and less institutionalized than integration in the independent firm-based behavioral model.

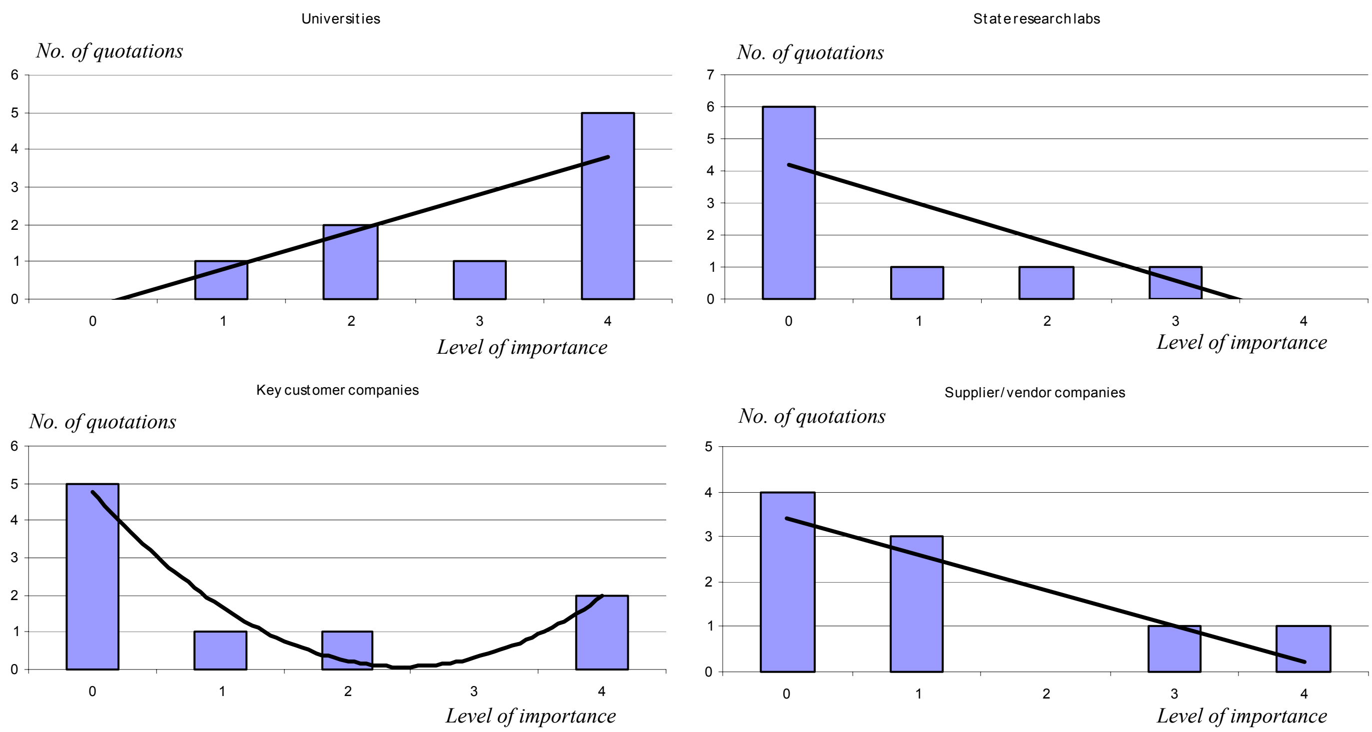
4.3.4.1 CAMBRIDGE INTEGRATION – IMPORTANCE OF COLLABORATION PARTNERS

The University of Cambridge, as indicated in Table 49, was the only collaboration partner of significant importance in the Cambridge sample.

	0	1	2	3	4	n/a	Total	Score
Universities	0	1	2	1	5	0	9	28
State research labs	6	1	1	1	0	0	9	6
Customer companies	5	1	1	0	2	0	9	11
Supplier companies	4	3	0	1	1	0	9	10
Complementary companies	2	3	1	3	0	0	9	14
Competitor companies	5	2	2	0	0	0	9	6

Table 49: Cambridge importance of collaboration partners

All other collaboration partner types were of medium to no importance as interfaces to the regional innovation system, except for the complementary technology companies category, which showed a medium level of importance. Key customer companies were important only to very few respondents. The histograms and trendlines of Figure 68 below give a visualization of the importance of the external collaboration partner types in Cambridge.



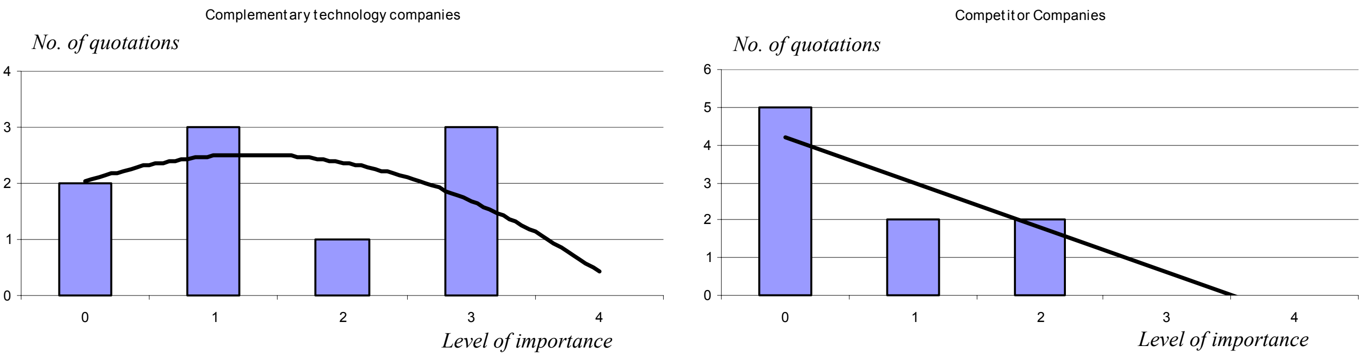


Figure 68: Cambridge importance of external collaboration partners

The limited importance of the state research labs is surprising taking into account the research orientation of the Cambridge RIS. However, it indicates that research in Cambridge is not state-driven. Cambridge, as noted above, is characterized by private initiative and private enterprise. Key customer companies are only of a very limited overall relevance since Cambridge is, as defined above, a science and technology-driven, and not a market-driven RIS. Supplier and vendor companies simply are not located in Cambridge or in the UK in most cases for that matter, and thus do not play an important role. Complementary technology companies play a role of intermediate overall importance. This can be attributed to the fact that the development-driven facilities in the sample are more oriented towards the small technology companies in their collaboration activity, whereas the research-driven facilities are more oriented towards the university as a collaboration partner. None of the respondents gave a rating of importance to competitor collaborations. This is an important indication of the proprietary approach taken to R&D in the Cambridge RIS.

4.3.4.2 CAMBRIDGE INTEGRATION – PROXIMITY TO COLLABORATION PARTNERS

Due to a lack of sufficient data in the Cambridge sample, it is not possible to discuss issues surrounding the physical distance to collaboration partners in this research.

4.3.4.3 CAMBRIDGE INTEGRATION – USE OF NETWORKS

4.3.4.3.1 Internal networks in Cambridge

Similar to London and Beijing, facility manager and R&D employee personal networks were by far the most important to activate interfaces to the regional innovation system. This is indicated in Table 50 below.

Internal networks	0	1	2	3	4	n/a	Total	Score
Mgr personal	0	0	1	2	6	0	9	32
Employee personal networks	0	0	1	3	5	0	9	31
Lab HR	4	2	1	2	0	0	9	10
Lab PR	5	0	3	0	1	0	9	10
Home country mgr personal	3	0	3	2	0	1	9	12
Host country non-R&D mgr personal	1	4	1	2	1	0	9	16

Table 50: Cambridge importance of internal networks

Internal human resources and public relations departments as well as host country based non-R&D managers were hardly or not at all important, whereas home country based managers on average were of medium importance. The picture corresponds with the small is beautiful character of the innovation system, made up of close personal networks that can often be traced to former academic activity at the University. Human resources and public relations departments are not used to drive regional integration in this environment. Neither do UK-based non-R&D managers of the facilities' parent companies get very involved in the integration process. Integration instead is left up to the individuals working in the foreign-owned facility.

4.3.4.3.2 External networks in Cambridge

External networks were of almost no significance at all (Table 51). For reasons mentioned above, none of the external networks were used to activate interfaces to the Cambridge RIS.

External networks	0	1	2	3	4	n/a	Total	Score
Consultant	5	1	2	1	0	0	9	8
Gov. matchmaking	5	4	0	0	0	0	9	4
Headhunter	4	2	0	2	1	0	9	12
PR firm	5	2	2	0	0	0	9	6
Ad agency	8	1	0	0	0	0	9	1

Table 51: The Importance of external networks in Cambridge

This image corresponds with the regional typology presented on Cambridge above. Personal initiative and long standing personal networks within the region count rather than external, third party service providers. In fact, the less their direct connection to technology, the more irrelevant external networks become to the integration process. This enables a classification of networks as a function of their degree of relatedness to the technology at stake. While R&D employees have a direct link to the technology, external advertising agencies will probably have no connection at all to the technology. In science and technology-driven regions, networks without a technology connection will probably not be used as much as in market- or cost-driven regions.

4.3.4.3.3 Networking platforms in Cambridge

Originally, due to the well established research infrastructure in Cambridge, research and industry associations with high levels of efficiency and value-added for participants and members were expected (Table 52).

Networking platforms	0	1	2	3	4	n/a	Total	Score
Industrial club	2	1	3	1	2	0	9	18
Non-industrial club	4	2	1	2	0	0	9	10
Open industrial	2	2	3	1	1	0	9	15
Open non-industrial	1	1	3	4	0	0	9	19

Table 52: Importance of networking platforms in the Cambridge innovation system

Indeed, the networking platforms were rated more important than the external networks. However all networking platform types except the non-industrial clubs (which played the least important role) received ratings distributed throughout all categories of zero to four. This shows that while networking platforms are used, they are by no means used intensively by the majority of facilities. In fact, there were more facilities that didn't use networking platforms at all than there were facilities that used them intensely. Open non-industrial network platforms, which cut across several industries or are of an academic nature, and are open to participation without membership, were of the greatest relevance since the academic exchange of knowledge, which lies at the core of the Cambridge model, is in fact open (public good character of knowledge).

4.3.4.4 Conclusion: regional integration in Cambridge

In conclusion, regional integration in Cambridge differs considerably from integration in Beijing or London. While personal initiative and personal networks based at and around the University are at the center of integration behavior in Cambridge, the government and government networks lie at the center of integration in Beijing. In London, regional integration is less of an issue altogether due to facilities' proximity to their parent company, the fact that the facilities are more development- than research-driven, and the fact that they have been present in the RIS for a long time. The University and complementary technology companies were the most important collaboration partners, while manager and employee personal networks were the most important personal networks. Third party external networks played no role at all, while networking platforms were only of slight importance, lead by open non-industrial networks. The personal network-driven integration behavior in the Cambridge RIS responds to the network-based integration behavior, which is furthermore characterized as virtue-based networking as opposed to necessity-based networking.

4.3.5 Integration behavior of foreign owned R&D in Stockholm

Due to the small size of the Stockholm sample (7 foreign-owned facilities), it is difficult to derive clear indications on integration behavior. However, it reflects the limited number of foreign-owned R&D facilities in Stockholm, so that the data is nonetheless of interest. Based on the Stockholm typology presented above, one would expect that regional integration here is somewhat similar to that of Cambridge, driven by personal networks rather than third party external service provider networks. Furthermore, the non-hierarchical, collaborative business culture commonly associated with Sweden is expected to provide for an internationally open environment, enabling fast integration not only due to its openness but also due to its limited size. The development-, design- and customer service-driven missions of foreign R&D facilities indicate that parent company and key customer company proximity may play an especially important role here.

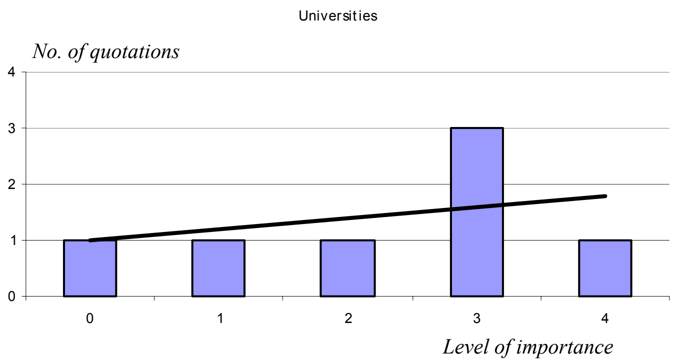
4.3.5.1 Stockholm Integration – Importance of Collaboration Partners

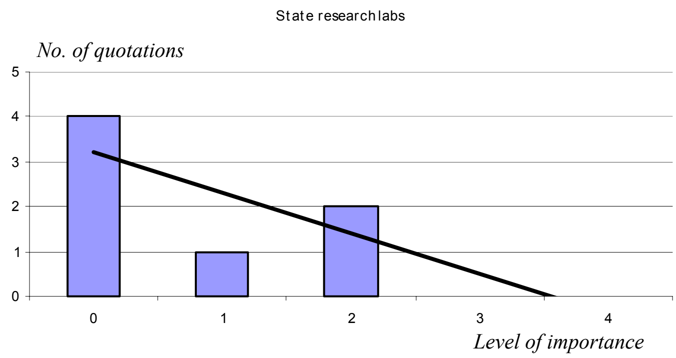
Indicated in Table 53, customer companies were the most important collaboration partners in the Stockholm cluster, followed by universities – while the university collaborations were of a recruitment rather than of a research nature.

	0	1	2	3	4	n/a	Total	Score
Universities	1	1	1	3	1	0	7	16
State research labs	4	1	2	0	0	0	7	5
Customer companies	0	0	2	3	2	0	7	21
Supplier companies	2	0	3	1	1	0	7	13
Complementary companies	2	1	3	1	0	0	7	10
Competitor companies	2	3	2	0	0	0	7	7

Table 53: Stockholm importance of collaboration partners

The collaboration partner types that were of least importance were state research labs and competitor companies. Supplier companies and complementary companies ranked in the middle. The following histograms and trendlines in Figure 69, illustrate this situation.





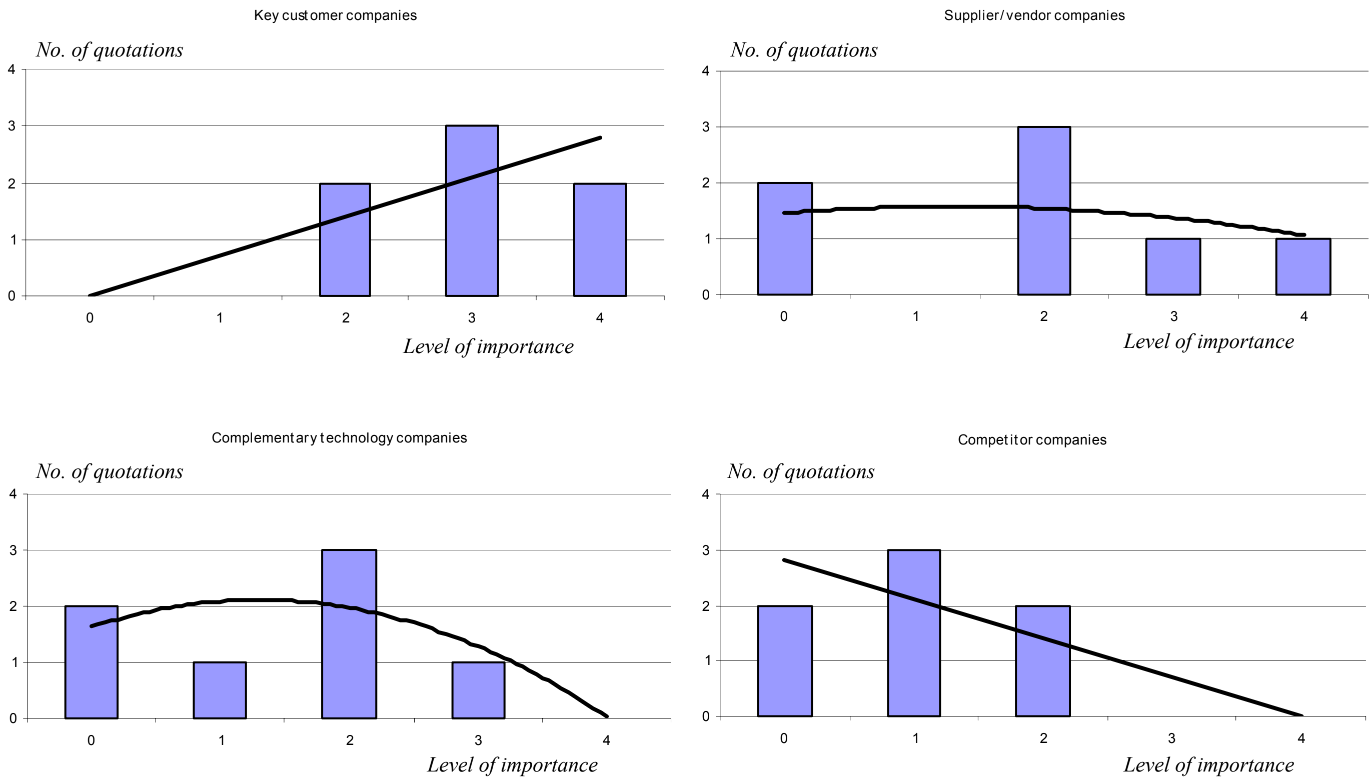


Figure 69: Stockholm importance of collaboration partners

The six histograms clearly visualize the focus on key customer companies and universities. State research labs and competitor companies played the least important roles, while supplier/vendor companies and complementary technology companies were of medium importance. The data supports the original claim that Stockholm is characterized by R&D that is development-, design-, and customer service-driven in terms of R&D missions, following key customer company-driven motives in most cases, and S&T-driven motives in a few other cases (complementary technology collaborations).

4.3.5.2 STOCKHOLM INTEGRATION – DISTANCE TO COLLABORATION PARTNERS

In Table 54, universities outside the host country received the largest number of grade four importance ratings, whereas universities at less than 0.5 hour driving distance received the most grade three importance ratings, and the highest overall score.

Universities	0	1	2	3	4	n/a	Total	Score
Less 0.5	1	1	1	3	1	0	7	16
0.5-2	2	1	2	2	0	0	7	11
more 2	2	2	3	0	0	0	7	8
Outside country	3	0	2	0	2	0	7	12
State research labs	**0**	**1**	**2**	**3**	**4**	**n/a**	**Total**	**Score**
less 0.5	4	1	2	0	0	0	7	5
0.5-2	0	2	1	0	1	3	7	8
more 2	1	1	1	1	0	3	7	6
Outside country	2	2	0	0	0	3	7	2
Suppliers/vendors	**0**	**1**	**2**	**3**	**4**	**n/a**	**Total**	**Score**
less 0.5	0	1	1	2	1	2	7	13
0.5-2	0	1	2	2	0	2	7	11
more 2	3	2	0	0	0	2	7	2
Outside country	0	0	1	3	1	2	7	15
Lead customer companies	**0**	**1**	**2**	**3**	**4**	**n/a**	**Total**	**Score**
less 0.5	0	0	2	3	2	0	7	21
0.5-2	0	1	3	1	2	0	7	18
more 2	1	2	1	3	0	0	7	13
Outside country	3	3	0	0	1	0	7	7
Complementary tech. partners	**0**	**1**	**2**	**3**	**4**	**n/a**	**Total**	**Score**
less 0.5	0	2	2	0	1	2	7	10
0.5-2	2	2	0	1	0	2	7	5
more 2	3	2	0	0	0	2	7	2
Outside country	1	1	1	1	1	2	7	10
Competitor companies	**0**	**1**	**2**	**3**	**4**	**n/a**	**Total**	**Score**
less 0.5	1	2	1	0	1	2	7	8
0.5-2	1	2	0	2	0	2	7	8
more 2	3	1	0	0	0	3	7	1
Outside country	0	0	3	0	1	3	7	10

Table 54: Stockholm physical distance to collaboration partners

It seems that the question of distance to collaborating universities is not overly relevant. This makes sense for recruitment-driven collaborations and collaborations that are formalized to the point where frequent face-to-face interaction is not required.

The collaboration with state research labs, when it did take place, did not seem to follow considerations of physical proximity either. The two radiuses that played the most important roles were the 0.5-2 hour and the more than 2 hour radiuses. However, the indication is rather weak, an interpretation is difficult. The development-, design-, and key customer focus in the sample indicates that minimal considerations are made concerning state research labs and their distance from the facilities.

Key customers collaborations on the other hand clearly follow considerations of physical proximity, indicated by a steadily decreasing importance of radiuses with increasing distance from the facilities. The less than 0.5 hour and 0.5 to 2 hour radiuses received the same number of grade four importance ratings, whereas neither of the two received any grade zero importance ratings. The facilities in the Stockholm sample from the start were characterized as very key customer company-focused.

A pattern emerges concerning the physical proximity to supplier/vendor companies: supplier/vendor companies at very close radiuses are important as well as those located outside of the home country. For globally operating firms, supplier/vendor companies typically take on two forms: (1) small companies providing cutting edge small technological components, and (2) large, scale-driven suppliers providing commodity type components. The type (1) suppliers are typically located in technological lead regions (such as Stockholm for the emerging mobile computing fields), whereas the type (2) suppliers are typically located in low wage production locations (i.e. such as Taiwan for semiconductor components). Since the global firms' products depend on both forms of suppliers, the Stockholm facilities need to collaborate with both to deliver technological solutions.

A similar pattern emerges concerning the complementary technology company collaborations. The logic for collaboration here is very similar to that of collaboration with suppliers/vendors. Small, high-end and technologically advanced companies may be located directly within the Stockholm innovation system, whereas larger, providers of more generic, commodity-type complementary technologies will typically be located outside the host country.

Again, a somewhat similar proximity pattern can be found regarding collaboration with competitor companies. Due to the small size of the Stockholm economy, outside the host country collaborations are in total more important than in other innovation systems such as London, where the population of companies and the size of the local economy is much larger. Whereas competitor companies as such did not play much of a role in the collaboration efforts of the Stockholm facilities, the data shows that when this type of collaboration did go on, it would occur either outside the country, or within a radius of up to a 2 hour driving distance.

4.3.5.3 STOCKHOLM INTEGRATION – USE OF NETWORKS

4.3.5.3.1 Internal networks in Stockholm

The picture in Table 55 is similar to that of the other regions examined. Manager and employee personal networks are by far the most important.

Internal networks	0	1	2	3	4	n/a	Total	Score
Mgr personal	0	1	0	4	2	0	7	21
Empl. personal	0	0	0	4	3	0	7	24
Lab HR	5	2	0	0	0	0	7	2
Lab PR	3	3	1	0	0	0	7	5
Home country mgr personal	1	3	1	2	0	0	7	11
Host country non-R&D mgr personal	0	2	3	2	0	0	7	14

Table 55: Stockholm importance of internal networks

Once again, human resources and public relations departments do not play an important role. As expected, the managers of non-R&D parent company facilities play an important role in integration. This can be expected where ever add-on entry modes are frequent. Due to the small size of the Swedish economy and the small size of the foreign-owned R&D facilities based there, home-country based managers also play a fairly important role in activating interfaces to the regional innovation system.

4.3.5.3.2 External networks in Stockholm

The external networks in Table 56 proved not even half as important to the integration process as the internal networks.

External networks	0	1	2	3	4	n/a	Total	Score
Consultant	3	0	1	2	1	0	7	12
Gov. matchmaking	3	3	0	1	0	0	7	6
Headhunter	5	1	0	1	0	0	7	4
PR firm	6	1	0	0	0	0	7	1
Ad agency	4	3	0	0	0	0	7	3

Table 56: The importance of external networks in Stockholm

All five external network categories received more grade zero importance ratings than other ratings. As was the case with other regions examined, the irrelevance of these external networks seems greatest for external public relations and advertising agencies, followed by headhunters, consultants and government matchmaking initiatives. One of the reasons for this irrelevance might be the small size of the country in which academic leaders know each other, so that there is no need for external, third party networking services. The fact that the foreign facilities are mostly headed by Swedish R&D managers supports this argument.

4.3.5.3.3 Networking platforms in Stockholm

In Table 57, networking platforms are perceived as more important in the Stockholm innovation system than the external networks.

Networking platforms	0	1	2	3	4	n/a	Total	Score
Industrial club	0	4	1	2	0	0	7	12
Non-industrial club	4	2	1	0	0	0	7	4
Open industrial	0	3	4	0	0	0	7	11
Open non-industrial	3	3	1	0	0	0	7	5

Table 57: Stockholm importance of networking platforms

Industrial club and open industrial networks are most important. This may be explained by the fact that the platforms enable the employees of foreign-owned facilities to gain a quick overview of and access to local counterparts. The data shows once again shows that external platforms are used more when they offer clear industry focus, as opposed to non-industry specific topics. However, none of the networking platforms received grade four importance ratings, and only the industrial club networks received grade three importance ratings. Again, this seems typical for a small country with close-knit personal networks and a flat hierarchy business environment.

4.3.5.4 CONCLUSION: INTEGRATION BEHAVIOR IN STOCKHOLM

In conclusion, the integration behavior in Stockholm is determined mostly by key customer company-driven, and sometimes S&T-driven motives of R&D internationalization, and by the small size of the RIS, implying that researchers and developers in a given field are generally known to each other. Third party service providers and networking platforms are thus of no great importance. The frequent development-, design-, and customer service-driven R&D missions imply that university collaborations are mostly recruitment driven. The data thus provides comprehensive support for the original regional typologies. Collaborations outside of the host country are frequently as important as those within the immediate vicinity of the Stockholm facilities. A distinction was therefore made between collaborations with companies providing (1) cutting edge components produced or developed in the host country, and (2) commodity components produced or developed in other, typically low wage countries.

4.3.6 Integration behavior of foreign owned R&D in Munich

The Munich sample, just like Beijing and Stockholm, showed quite a number of add-on entries and a strong development focus. However, Munich location decisions were influenced more strongly by Munich's strong (basic and applied) state research labs than the other regions. Due to this and the large size of the RIS, integration initiatives in Munich are expected to be more public institutions- and platform-driven than those in Cambridge and Stockholm, and more recruitment- and more parent company-driven than those in Cambridge.

4.3.6.1 MUNICH INTEGRATION – IMPORTANCE OF COLLABORATION PARTNERS

In line with the diversity-driven triple-helix character of the Munich RIS, the data in Table 58 shows that universities, supplier/vendor companies, state research labs, and key customer companies each were important collaboration partners.

	0	1	2	3	4	n/a	Total	Score
Universities	0	2	4	3	7	0	16	47
State research labs	3	0	2	10	1	0	16	38
Customer companies	2	5	0	5	4	0	16	36
Supplier/vendor companies	1	2	3	7	3	0	16	41
Complementary companies	4	4	3	3	2	0	16	27
Competitor companies	8	3	4	1	0	0	16	14

Table 58: The importance of collaboration partners in Munich

Complementary technology companies were of medium importance, while competitor companies were not important. The relatively high importance of so many collaboration partner types is a distinct characteristic of the Munich RIS and is indicated by the histograms and trendlines presented below in Figure 70.

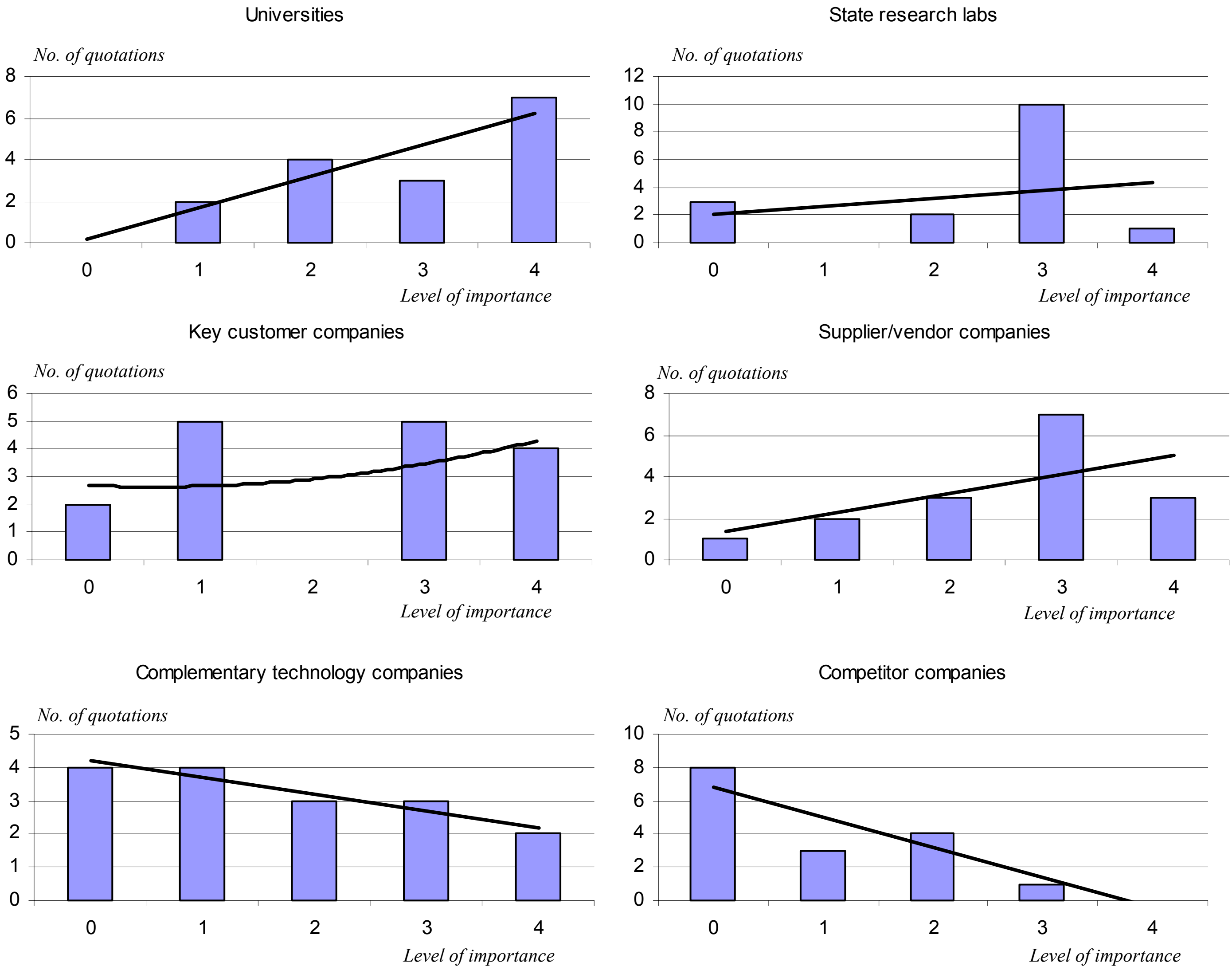


Figure 70: Munich importance of collaboration partners

As indicated above, universities, state research labs, key customer companies, and supplier/vendor companies are, on average, all relatively important for foreign-owned facilities' integration in the Munich RIS. Competitor companies and complementary technology companies were not important. Munich, as portrayed in the opening regional typology, has a very diverse innovation system, lacking a clear center of gravity. As a combination of urban-, university-, key company-, and government-centric typologies, the Munich triple-helix phenomenon has made Munich the first technology location in Germany.

Universities and state research labs were of a medium to high importance to most interviewees. Customer companies clustered in two areas: eight interviewees found them to be of little or no importance, nine interviews found them to be of high or very high importance. Complementary company collaborations were rated of medium importance, while competitor company collaborations were of medium to no importance. Though the data shows that collaboration was more diverse in the Munich RIS than at the other locations covered in this study, it is not possible to derive conclusions as to the character of integration behavior in the sense of the MMB model yet.

4.3.6.2 MUNICH INTEGRATION – PROXIMITY TO COLLABORATION PARTNERS

Proximity practically did not matter for university collaborations (Table 59). Less than 0.5 hours, more than 2 hours, and outside the host country radiuses received approximately the same importance ratings.

Universities	0	1	2	3	4	n/a	Total	Score
less 0.5	4	2	3	2	4	1	16	30
0.5-2	5	2	5	1	2	1	16	23
more 2	3	0	6	4	2	1	16	32
Outside country	4	2	3	3	3	1	16	29
State research labs	**0**	**1**	**2**	**3**	**4**	**n/a**	**Total**	**Score**
less 0.5	9	3	0	2	0	2	16	9
0.5-2	6	0	5	3	0	2	16	19
More 2	3	0	1	8	2	2	16	34
Outside country	4	2	3	2	2	3	16	22
Key customer companies	**0**	**1**	**2**	**3**	**4**	**n/a**	**Total**	**Score**
less 0.5	6	1	2	4	2	1	16	25
0.5-2	6	2	3	2	2	1	16	22
more 2	4	1	2	4	4	1	16	33
Outside country	1	3	1	4	6	1	16	41
Supplier/vendor companies	**0**	**1**	**2**	**3**	**4**	**n/a**	**Total**	**Score**
less 0.5	7	2	1	3	2	1	16	21
0.5-2	6	2	2	1	4	1	16	25
more 2	5	3	1	4	2	1	16	25
Outside country	2	3	2	3	5	1	16	36
Complementary technology companies	**0**	**1**	**2**	**3**	**4**	**n/a**	**Total**	**Score**
less 0.5	7	3	2	2	0	2	16	13
0.5-2	6	2	5	0	1	2	16	16
more 2	4	2	4	1	3	2	16	25
Outside country	3	2	4	2	3	2	16	28
Competitor companies	**0**	**1**	**2**	**3**	**4**	**n/a**	**Total**	**Score**
less 0.5	8	2	1	0	0	5	16	4
0.5-2	7	1	2	1	0	5	16	8
more 2	5	1	3	2	0	5	16	13
Outside country	5	0	2	2	2	5	16	18

Table 59: The physical distance to collaboration partners in Munich

Regardless of Munich hosting several of Germany's leading state research and development institutes, the importance of state research lab collaborations increased with increasing distance from the facilities. In Germany, probably due to its decentralized industrial structure, the national innovation system thus seems to play a larger role than the countries of the other locations studied. Lead customer collaborations did not in any way favor physical proximity either. In fact, importance increased with increasing distance from the foreign facilities as does the importance of collaborations with supplier/vendor companies, complementary technology companies, and competitor companies.

In summary, proximity plays less of a role to the foreign-owned facilities in Munich than it does in any of the other regions examined. This could be explained by the independent firm-based behavioral model, as well as the fact that the Munich RIS is very development-driven, and is thus determined by less tacit and more explicit collaborations requiring less physical proximity. However, an emerging insight is that proximity plays less of a role in Munich simply due to the fact that Germany is more decentralized than any of the other regions examined, and that high-quality knowledge carriers of all sorts are scattered about, so that long distance collaborations may not be virtue, but necessity. On the other hand, it could also indicate that proximate collaborations in the other regions are simply given, due to the industrial concentration at the studied locations.

4.3.6.3 MUNICH INTEGRATION – USE OF NETWORKS

4.3.6.3.1 Internal networks in Munich

As seen in Table 60, manager personal networks and employee personal networks are once again by far the most important.

Internal networks	0	1	2	3	4	n/a	Total	Score
Mgr personal	1	0	3	4	8	0	16	50
Empl. personal	0	1	0	7	8	0	16	54
Lab HR	8	4	1	1	2	0	16	17
Lab PR	6	5	2	1	2	0	16	20
Home country mgr personal	5	3	2	3	3	0	16	28
Host country non-R&D mgr personal	3	6	3	4	0	0	16	24

Table 60: Munich importance of internal networks

Internal human resources and public relations departments were of the least importance, while home country-based management and host country-based non-R&D managers played roles of medium importance.

4.3.6.3.2 External networks in Munich

Similar to the other regions examined, external third party service providers played very limited or no roles for foreign-owned facilities' regional integration in the Munich sample (Table 61).

External networks	0	1	2	3	4	n/a	Total	Score
Consultant	4	7	2	2	1	0	16	21
Gov. matchmaking	5	6	1	1	3	0	16	23
Headhunter	11	4	1	0	0	0	16	6
PR firm	11	4	1	0	0	0	16	6
Ad agency	10	3	2	1	0	0	16	10

Table 61: Munich importance of external networks

Headhunters played less of a role than they did in other regions, as did consultants and government matchmaking initiatives.

4.3.6.3.3 Networking platforms in Munich

Industrial clubs and open industrial networks lead the list of networking platforms used by foreign-owned R&D facilities in Munich (Table 62). Like in Stockholm, the networking platforms were more important than the external networks.

Networking platforms	0	1	2	3	4	n/a	Total	Score
Industrial club	3	2	1	6	4	0	16	38
Non-industrial club	10	1	2	3	0	0	16	14
Open industrial	2	4	3	5	2	0	16	33
Open non-industrial	6	4	4	2	0	0	16	18

Table 62: Munich importance of networking platforms

Also, industrial networks were more important than non-industrial networks. This can be explained by the development-focus of the Munich RIS, which requires industry-related rather than scientific research-related networking. In general however, networking platforms were given very limited importance. As one interviewee in the government of the Munich innovation system stated, networking platforms were a trend during the years of economic boom of the late 1990s. Since then, networks have been seeing less and less demand for their services, especially when they charge for them. As a consequence, many of the Munich based local, regional, and super-regional networks have been closing down.

4.3.6.4 CONCLUSION: REGIONAL INTEGRATION IN MUNICH

In conclusion, integration activities in Munich involved a wide array of collaboration partners, but with no clear preference for physical proximity. Manager and R&D employee personal networks were the most important network types, followed at quite a distance by industrial networking platforms. The development- and market-driven orientation of the Munich RIS, as well as the independent firm-based character of the system fit well with this integration behavior. The importance of collaboration partners that were at more than 2 hours from the facility shows the decentralized nature of the Germany economy, while the importance of partners outside the host country shows similarity to collaboration in the Stockholm RIS, possibly due to the two generic collaboration types that were identified relating to cutting edge versus generic contributors to the R&D process.

4.3.7 Summary: overview of foreign-owned R&D integration

4.3.7.1 COLLABORATION PARTNERS

While universities played key roles in each of the locations, all locations except Cambridge also had special affinities to key customer companies, as can be seen in Table 63.

	Key collaboration partners
Beijing	Universities, key customer companies
London	Universities, key customer companies
Cambridge	University, complementary technology companies
Stockholm	Universities, key customer companies, complementary technology companies
Munich	Universities, state research labs, key customer companies, supplier/vendor companies

Table 63: Overview of key collaboration partners

Cambridge and Stockholm facilities furthermore collaborated with complementary technology companies, and Munich facilities furthermore collaborated with state research labs and supplier/vendor companies.

4.3.7.2 DISTANCE TO COLLABORATION PARTNERS

Collaborations in Beijing were spread out across the 0.5h, 0.5-2h, and more than 2h within the host country radiuses (Table 64).

	Distance to collaboration partners					
	Universities	**State research**	**Suppl./vendor co's**	**Customer co's**	**Compl. techn. co's**	**Competitor co's**
Beijing	<0.5h, +2h	<0.5h, 0.5-2h	<0.5h, outside h.c.	0.5-2h, +2h	<0.5h, 0.5-2h	n/a
London	n/a	n/a	n/a	n/a	n/a	n/a
Cambridge	n/a	n/a	n/a	n/a	n/a	n/a
Stockholm	<0.5h, outside h.c.	0.5-2h, +2h	<0.5h, outside h.c.	<0.5h, 0.5-2h	<0.5h, outside h.c.	<0.5h-2h, outside h.c.
Munich	<0.5h, +2h	+2h, outside h.c.	+2h, outside h.c.	0.5-2h, +2h outside h.c.	+2h, outside h.c.	+2h, outside h.c.

Table 64: Overview of distance to collaboration partners

No clear need for physical proximity to partner companies can be seen here. Insufficient data was available to discuss the distance to collaboration partners in London and Cambridge. In Stockholm, most collaborations took place either within the two hour radius of the facility, or outside of the country. Thus, three proximity models can be developed: (1) proximity dependent networking locations, (2) proximity independent networking locations, and (3) locations with both proximity dependent and independent collaborations. Munich, with most of the collaborations going on either in the more than 2h within the host country and the outside the host country radiuses, is the basis for yet another proximity-driven model: networking proximity may be a function of the degree of economic centralization of the locations' greater surrounding: due to Germany's decentralization, most collaboration takes place with partners at a distance of more than two hours, or with partners outside the host country.

4.3.7.3 NETWORKS

Across all locations studied, R&D manager and R&D employee personal networks played the most important roles by far (Table 65).

	Networks used for integration		
	Internal	**External**	**Networking platforms**
Beijing	Manager and employee personal networks	Consultants, government matchmaking	Open industrial networks, industrial club networks
London	Manager and employee personal networks	Consultants, government matchmaking	Open industrial networks, industrial club networks
Cambridge	Manager and employee personal networks	None	None
Stockholm	Manager and employee personal networks	None	None
Munich	Manager and employee personal networks	None	None

Table 65: Overview of networks used for integration

In terms of external networks, which were overall much less important than internal networks, consultants and government matchmaking services played a role in Beijing and London, while none of the other regions found any of the external networks to be of any relevance. Among the networking platforms, which got overall higher importance ratings than the external networks, open industrial networks and industrial club networks played roles in Beijing and London, whereas none of the networking platforms were of importance to the other locations. The above analyses of integration behavior offer empirical support for both the regional typologies, as well as the facility-driven MMB model originally associated with the regions and their foreign-owned R&D facilities.

4.4 Summary: analysis of intra-regional behavior

The five locations examined in the context of foreign-owned R&D are highly heterogeneous. The intra-regional analysis found far-ranging support for both the regional typologies as well as the MMB model as a tool to distinguish between foreign-owned R&D facilities in different regional settings. Whereas the regions differed widely in terms of facility sizes, growth rates, and management nationalities, they were more homogenous in terms of the sizes of their partnership networks. Taking into account the MMB model, distinct differences were identified in terms of motives and missions for conducting R&D in the specific regions. The entry modes were mostly greenfield investments and acquisitions, while Beijing displayed almost only greenfield investments. While collaboration partners in the five regions varied, universities were of importance in each region, in certain cases for research collaborations, in other cases for recruitment collaborations. The distances to collaboration partners seemed to vary between three principal models: (1) physical proximity is sought, (2) physical proximity is not especially sought, and (3) partners are located both very close and very far away from the site of the foreign-owned facility. In terms of networks, manager and employee personal networks were of central importance in each of the regions. Consultants, government matchmaking, and industrial networks played a role only in Beijing and London. To complement the intra-regional analysis conducted above, the following section examines global trends in the internationalization of R&D.

Section 5: global analyses

5.1 Introduction

This section of the research groups the 62 foreign-owned R&D facilities into a single, global sample. Pearson correlations are calculated to identify global trends in how foreign owned R&D facilities enter into and integrate with regional innovation systems. In addition to the regional models and specificities identified above, numerous global patterns emerge through this analysis. A key aim of the research is the establishment of models for the internationalization of R&D at the regional and at the global levels. The structure of this section of the research is similar to that of the intra-regional analyses covered above. Subsections are dedicated to (1) the global character of foreign-owned R&D, (2) global entry behavior, and (3) global integration behavior, discussing in how far each of them are determined by different variables in from the research.

5.2 Statistical method: Pearson correlations

Pearson's correlation coefficient, a bivariate correlations method, is a measure of linear association using symmetric quantitative variables. Correlations measure how variables or rank orders are related. Pearson's correlation coefficient assumes that each pair of variables is bivariate normal. Correlation coefficients range in value from –1 (a perfect negative relationship) and +1 (a perfect positive relationship). A value of 0 indicates no linear relationship. Two-tailed tests of significance are conducted along with the computation of the correlation coefficients. In the discussion of the results, only correlations significant at the 0.05 level and the 0.01 level and with meaningful implications for the establishment of global trends in R&D internationalization are presented and discussed. Cases with missing values for one or both of a pair of variables for a correlation coefficient are excluded from the analysis. In this study, Pearson correlations were calculated using the software SPSS. The program indicates correlations at difference levels of significance, thus enabling a fast overview of relevant correlations between large numbers of variables.

5.3 The global character of R&D

5.3.1 R&D mission

The positive correlations at the 0.01 level of significance in Table 66 show that facilities with development-driven missions were more likely than research-driven facilities to chose locations based on the presence of key customer companies, while they were more likely to collaborate with key customer companies and supplier/vendor companies than research-driven facilities.

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Entry: Location choice (key drivers and supporting factors, character of location choice)				
Key customer companies	0,426	0,001	60	Significant at the 0.01 level (2-sided)
Character of location choice	0,349	0,008	57	Significant at the 0.01 level (2-sided)
Single scientist (key driver)	-0,304	0,034	49	Significant at the 0.05 level (2-sided)
Leading techn. region (key driver)	-0,364	0,010	49	Significant at the 0.05 level (2-sided)
R&D environment	-0,385	0,002	60	Significant at the 0.01 level (2-sided)
Strong state research	-0,405	0,001	59	Significant at the 0.01 level (2-sided)
Single univ. institute (key driver)	-0,425	0,002	49	Significant at the 0.01 level (2-sided)
Strong university research	-0,638	0,000	60	Significant at the 0.01 level (2-sided)
Integration: Collaboration partners (importance in the integration process)				
Key customer companies	0,513	0,000	59	Significant at the 0.01 level (2-sided)
Supplier/vendor companies	0,425	0,001	59	Significant at the 0.01 level (2-sided)
Complementary companies	0,292	0,025	59	Significant at the 0.05 level (2-sided)
Universities	-0,555	0,000	58	Significant at the 0.01 level (2-sided)
Integration: Networks (importance in the integration process)				
Gov. matchmaking networks	-0,271	0,038	59	Significant at the 0.05 level (2-sided)
Non-industrial club networks	-0,339	0,009	59	Significant at the 0.01 level (2-sided)
Employee personal networks	-0,461	0,000	59	Significant at the 0.01 level (2-sided)

Table 66: Variables significantly correlating with R&D mission

The location choice of development-driven facilities proved more intuitive/ emotional than that of research-driven facilities, which was more lengthy/analytical in its nature. At the 0.05 level of significance, development-driven facilities were more likely to collaborate with complementary technology companies than research-driven facilities.

The negative correlations at the 0.01 level of significance in the table show that strong university research played more of a role in location decisions of research-driven facilities than in those of development-driven facilities, as did single university institutes, state research labs and the general R&D environment. University collaborations were more likely with research-driven facilities than with development-driven facilities. Furthermore, employee personal networks and industrial club networks were more important to research-driven facilities than to development-driven facilities. At the 0.05 level of significance, research-driven facilities more often indicated that single scientists or the leading foreign technology region were key drivers in the location decision than development-driven facilities.

5.3.2 Facility age

The data in Table 67 shows that older facilities in the global sample also had more R&D employees, and that older facilities were founded with larger numbers of R&D staff than younger facilities.

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: Size, character of knowledge work				
R&D employees today	0,535	0,000	61	Significant at the 0.01 level (2-sided)
R&D employees at founding	0,492	0,000	58	Significant at the 0.01 level (2-sided)
Collaborative vs. proprietary	0,261	0,047	58	Significant at the 0.05 level (2-sided)
Integration: Networks (importance in the integration process)				
Headhunter networks	0,442	0,000	59	Significant at the 0.01 level (2-sided)
Ad agency networks	0,258	0,049	59	Significant at the 0.01 level (2-sided)

Table 67: Variables significantly correlating with facility age

It also shows that older facilities ranked headhunter and advertising agency networks as more important than the younger facilities. Finally, there is a correlation at the 0.05 level of significance between age and character of knowledge work: Age correlated positively with the collaborative character of the knowledge work: the older the facility, the more proprietary the knowledge work conducted there. The global data on variables correlating with facility age supports the regional typologies and earlier implications of the MMB model: London, as the oldest RIS in the study, was least collaborative and had the largest facilities. Thus, the independent firm-based behavioral model is confirmed for London by the data in Table 67 above.

5.3.3 Facility size and growth

5.3.3.1 SIZE

The data in Table 68 shows that larger facilities also had larger numbers of R&D personnel at founding, indicating that, as formulated above, large-founded facilities stay larger, whereas small-founded facilities stay smaller.

Independent variables	**Pearson Correlation**	**Significance (2-sided)**	**N**	**Significance Level**
Characteristics: Age, size, growth, size of partner networks				
R&D employees at founding	0,870	0,000	58	Significant at the 0.01 level (2-sided)
Size of key partner network	0,523	0,000	41	Significant at the 0.01 level (2-sided)
Size of other partner network	0,507	0,001	41	Significant at the 0.01 level (2-sided)
Employee growth p.a.	0,268	0,042	58	Significant at the 0.05 level (2-sided)
Age (founding year)	-0,535	0,000	61	Significant at the 0.01 level (2-sided)

Table 68: Variables significantly correlating with facility size

The data also shows a slight positive correlation between employee growth p.a. and size, indicating that larger facilities grew over- proportionally quickly in the sample. Contrary to earlier presumptions, the data shows that larger facilities also had larger key and other partner networks. The above hypothesis that smaller facilities may entertain larger key and other partner networks to compensate for lack of proprietary assets, is thus rejected at this point. Finally, Table 68 shows that older facilities in the sample were larger than younger facilities. This could be a result either of the fact that there is a trend towards smaller foreign R&D facilities, or simply of the fact that R&D centers grow over time. Once again, this data confirms the regional typologies.

5.3.3.2 GROWTH

None of the correlations in this case exceeded the 0.05 level of significance. Table 69 shows that facilities with the stronger growth on average were larger and had larger key and other partner networks.

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: Size, nationality of management, size of partner networks, character of knowledge work				
Size of key partner network	0,330	0,035	41	Significant at the 0.05 level (2-sided)
Size of other partner network	0,314	0,046	41	Significant at the 0.05 level (2-sided)
R&D employees today	0,268	0,042	58	Significant at the 0.05 level (2-sided)
Nationality of R&D manager	-0,280	0,034	58	Significant at the 0.05 level (2-sided)
Tacit vs. explicit	-0,285	0,035	55	Significant at the 0.05 level (2-sided)
Collaborative vs. proprietary	-0,330	0,014	55	Significant at the 0.05 level (2-sided)
Entry: Location decision (key factor)				
Leading technology region	-0,338	0,017	49	Significant at the 0.05 level (2-sided)

Table 69: Variables significantly correlating with facility growth

It furthermore shows that companies with home country nationality R&D managers grew slightly quicker than those with home country nationality managers. Correlations with the character of facilities' knowledge work show that faster growing facilities conducted knowledge work that was more collaborative and more tacit in nature than slower growing facilities. Finally, fast growing facilities found being present in a leading technology region less important than slower growing facilities. The data supports a presumption made earlier in this work concerning facility growth: fast growing facilities were assumed to be lead more often by home country nationals since they enable better control by the parent company.

5.3.4 Nationality of R&D manager

Facilities with host country management grew slower and were more explorative than facilities with home country management (Table 70).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: Growth, character of knowledge work				
Employee growth p.a.	-0,280	0,034	58	Significant at the 0.05 level (2-sided)
Explorative vs. exploitative	-0,263	0,045	59	Significant at the 0.05 level (2-sided)
Entry: Location choice (key drivers and supporting factors)				
Company to be acquired (key driver)	0,297	0,038	49	Significant at the 0.05 level (2-sided)
Large target market growth	-0,267	0,039	60	Significant at the 0.05 level (2-sided)
Government financial incentives	-0,433	0,001	58	Significant at the 0.01 level (2-sided)
Integration: Networks				
Manager personal networks	0,323	0,013	59	Significant at the 0.05 level (2-sided)

Table 70: Variables significantly correlating with R&D manager nationality

Furthermore, host country managers more often cited acquisitions as key location determinants than home country managers. Home country national R&D managers on the other hand attributed a greater relevance to large target market growth and government financial incentives than host country R&D managers. Manager personal network were graded more important by host country national R&D managers than by home country national R&D managers.

In summary, home country nationality R&D managers in the sample are more likely to run development-driven type facilities aimed at fast growth and lively collaboration with external knowledge sources. Host country nationals are more likely to run research-driven facilities, driven by their own personal network, explorative R&D, and international collaborations.

5.3.5 Size of partner network

5.3.5.1 SIZE OF KEY PARTNER NETWORK

Those facilities with large key partner networks also had large other partner networks (see Table 71). Therefore, a distinction between partnership networks of breadth versus partnership networks of depth as proposed above becomes irrelevant.

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: Size, growth, size of other partner network				
Size of other partner network	0,943	0,000	41	Significant at the 0.01 level (2-sided)
R&D employees today	0,523	0,000	41	Significant at the 0.01 level (2-sided)
R&D employees at founding	0,511	0,001	41	Significant at the 0.01 level (2-sided)
Employee growth p.a.	0,330	0,035	41	Significant at the 0.05 level (2-sided)
Entry: Key driver of location decision				
Important foreign market potential	-0,320	0,044	40	Significant at the 0.05 level (2-sided)

Table 71: Variables significantly correlating with size of key partner network

As mentioned above, larger key partner networks were furthermore observed with larger and faster growing facilities. Thus, while the size of the foreign-owned facility does not seem to influence the size of the partner networks as originally supposed, the rate of growth however does seem to correlate with partner network size.

Facilities with smaller key partner networks more often chose locations due to an important foreign market potential than facilities with larger key partner networks, implying that market-driven R&D facilities may have smaller key partner networks than science and technology- or cost-driven R&D facilities.

5.3.5.2 SIZE OF OTHER PARTNER NETWORK

A picture similar to that generated by size of key network correlations above, also applies to the correlations with size of the other partner network (Table 72). Facility size and growth rates correlated positively, as did size of key partner network.

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: Size, growth, size of key partner networks				
Size of key partner network	0,943	0,000	41	Significant at the 0.01 level (2-sided)
R&D employees today	0,507	0,001	41	Significant at the 0.01 level (2-sided)
R&D employees at founding	0,481	0,001	41	Significant at the 0.01 level (2-sided)
Employee growth p.a.	0,314	0,046	41	Significant at the 0.05 level (2-sided)

Table 72: Variables correlating significantly with size of other partner network

5.3.6 Character of knowledge work

5.3.6.1 EXPLORATIVE VERSUS EXPLOITATIVE

The most obvious correlation in Table 73 is with R&D mission, confirming that research-driven R&D missions are typically explorative, whereas development-driven R&D missions are typically exploitative. The character of the location choice furthermore correlates positively.

Independent variables	**Pearson Correlation**	**Significance (2-sided)**	**N**	**Significance Level**
Characteristics: R&D mission				
R&D mission	0,634	0,000	59	Significant at the 0.01 level (2-sided)
Entry: Location choice (key drivers and supporting factors, character of location choice)				
Character of location choice	0,496	0,000	55	Significant at the 0.01 level (2-sided)
Key customer companies	0,418	0,001	58	Significant at the 0.01 level (2-sided)
Local experience of mgr	-0,310	0,018	58	Significant at the 0.05 level (2-sided)
Single univ. institute (key driver)	-0,344	0,017	48	Significant at the 0.05 level (2-sided)
R&D environment	-0,388	0,003	58	Significant at the 0.01 level (2-sided)
Leading techn. region (key driver)	-0,411	0,004	48	Significant at the 0.01 level (2-sided)
Strong university research	-0,488	0,000	58	Significant at the 0.01 level (2-sided)
Integration: Collaboration (importance of partners in the integration process)				
Supplier/vendor company collab.	0,316	0,016	58	Significant at the 0.05 level (2-sided)

Table 73: Variables significantly correlating with explorative/exploitative knowledge work

This indicates once again that exploitative R&D facility location decisions are conducted more intuitively and emotionally than explorative facility location decisions. Exploitative facilities furthermore find it more important to be close to customers companies than explorative facilities, while they collaborated more intensely with supplier/vendor companies. The negative correlations show that explorative facilities valued strong university research and a favorable R&D environment in their location decisions, as well as local experience of the designated lab manager. This data broadly supports the regional typologies as well as the implications of the MMB model within different regional contexts made above.

5.3.6.2 COLLABORATIVE VERSUS PROPRIETARY

Table 74 shows a positive correlation with a few networks, indicating that proprietary facilities attributed more relevance to headhunter, internal PR department, industrial club, and internal HR department networks than collaborative facilities.

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: Age and growth				
Age (founding year)	-0,261	0,047	58	Significant at the 0.05 level (2-sided)
Employee growth p.a.	-0,330	0,014	55	Significant at the 0.05 level (2-sided)
Entry: Location choice (supporting factors)				
Complementary techn. companies	0,265	0,046	57	Significant at the 0.05 level (2-sided)
Large target market	-0,269	0,043	57	Significant at the 0.05 level (2-sided)
Integration: Networks (importance to the integration process)				
Headhunter networks	0,369	0,005	57	Significant at the 0.01 level (2-sided)
Internal PR department networks	0,310	0,019	57	Significant at the 0.05 level (2-sided)
Industrial club networks	0,274	0,039	57	Significant at the 0.05 level (2-sided)
Internal HR department networks	0,265	0,046	57	Significant at the 0.05 level (2-sided)

Table 74: Variables significantly correlating with collaborative/proprietary knowledge work

Furthermore, proprietary facilities found it more important to locate proximate to complementary technology companies than collaborative facilities did. Collaborative work correlated negatively with age: the older the facilities, the less they tended towards collaborative knowledge work. Collaborative facilities on the other hand attributed higher levels of importance to the size of the target market, and grew faster than proprietary facilities. This indication is in line with data on collaboration partner network sizes. Faster growing facilities had larger networks and are, as indicated here in Table 74, more collaborative.

5.3.6.3 TACIT VERSUS EXPLICIT

According to the correlations in Table 75, the more explicit the character of the knowledge work, the more internal PR departments are used in the sample as interfaces to the regional innovation system. Furthermore, the more explicit the character of the knowledge work, the more important the size of the market potential in the location decision.

Independent variables (tacit vs. explicit)	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: Growth				
Employee growth p.a.	-0,285	0,035	55	Significant at the 0.05 level (2-sided)
Entry: Location choice (key driver)				
Market potential (key driver)	0,292	0,044	48	Significant at the 0.05 level (2-sided)
Integrations: Networks				
PR department networks	0,340	0,010	57	Significant at the 0.01 level (2-sided)

Table 75: Variables significantly correlating with tacit/explicit knowledge work

Tacit knowledge-driven facilities on the other hand were characterized on average by faster growth than explicit knowledge-driven facilities. These indications are in line with above observations on regional typologies and the MMB model within the regional contexts.

5.3.7 Conclusion on global character of R&D facilities

The data on global characteristics of foreign-owned R&D facilities supports the global validity of the MMB model within the sample. Pearson correlations indicate that facilities with research- versus development-driven R&D missions throughout the sample have similar characteristics, while the same goes for market- versus S&T-, cost- and key customer company-driven motives for the internationalization of R&D. In terms of integration behavior, only very limited insight on possible global patterns could be deduced from the above data.

5.4 The global entry behavior of R&D

5.4.1 Introduction

Examining global trends in the entry behavior of foreign-owned R&D facilities, Pearson correlations are calculated to find out which factors from the perspective of the global sample, have an influence on location decisions. The observations include correlations with key drivers of the location decisions as well as selected supporting factors. The data is briefly discussed with its implications on the regional typologies and the parameters of the MMB model in its regional contexts.

5.4.2 Key drivers of global location decisions

5.4.2.1 SINGLE SCIENTIST

As indicated in Table 76, the factors that correlated positively with single scientist relate to the local experience of the designated lab manager as well as university-driven interests.

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: R&D mission				
R&D mission	-0,304	0,034	49	Significant at the 0.05 level (2-sided)
Entry: Location choice (key drivers and supporting factors)				
Local experience of lab mgr	0,436	0,002	49	Significant at the 0.01 level (2-sided)
Single university institute (key driver)	0,349	0,014	49	Significant at the 0.05 level (2-sided)
Key suppliers/vendors	-0,317	0,027	49	Significant at the 0.05 level (2-sided)
Integration: Collaboration (importance for regional integration)				
Universities	0,385	0,007	48	Significant at the 0.05 level (2-sided)
Complementary techn. companies	-0,312	0,031	48	Significant at the 0.05 level (2-sided)
Integration: Networks (importance for regional integration)				
Host country non-R&D mgr networks	-0,286	0,046	49	Significant at the 0.05 level (2-sided)
Open industrial networks	-0,317	0,026	49	Significant at the 0.05 level (2-sided)

Table 76: Variables significantly correlating with single scientist

Negative correlations indicate that facilities that did not consider single scientists as a driver to the location decision were more likely to be development-driven. Their location decisions were furthermore less influenced by the local presence of key supplier/vendor companies and they were less interested in complementary technology company collaborations. Furthermore, they were less interested in open industrial networks and host country non-R&D manager networks than facilities in which single scientists were key drivers to the location decision.

5.4.2.2 SINGLE UNIVERSITY INSTITUTE

Those facilities that cited university institutes as key drivers in their location decisions more actively used open non-industrial (in other words: academic) networks than those that did not (Table 77). They were furthermore often attracted by strong local university research and single scientists, and collaborated more intensely with universities and physically proximate competitors than those that did not consider university institutes as key drivers of the location decision. Negative correlations exist with R&D mission, indicating that these facilities were more research-driven than development-driven. They furthermore found supplier/vendor collaborations to be of less importance and considered the presence of lead customer companies to be less important as supporting factors in the location decision. The negative correlation with explorative/exploitative indicates that facilities seeking a single university institute abroad were more explorative in their nature than exploitative.

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: R&D mission, explorative vs. exploitative				
R&D mission	-0,425	0,002	49	Significant at the 0.01 level (2-sided)
Explorative vs. exploitative	-0,344	0,017	48	Significant at the 0.05 level (2-sided)
Entry: Location choice (key drivers and supporting factors)				
Strong university research	0,477	0,001	49	Significant at the 0.01 level (2-sided)
Single scientist (key-driver)	0,349	0,014	49	Significant at the 0.05 level (2-sided)
Lead customer companies	-0,371	0,010	48	Significant at the 0.05 level (2-sided)
Integration: Collaboration partners important to the integration process				
Universities	0,417	0,003	48	Significant at the 0.01 level (2-sided)
Supplier/vendor companies	-0,346	0,016	48	Significant at the 0.05 level (2-sided)
Integration: Networks important to the integration process				
Open non-industrial networks	0,558	0,000	49	Significant at the 0.01 level (2-sided)

Table 77: Variables significantly correlating with key driver 'single university institute'

5.4.2.3 SPECIFIC COMPANY TO BE ACQUIRED

At the 0.01 level of significance in Table 78, those respondents that cited specific companies to be acquired as key drivers in the location decision at the same time cited specific companies to collaborate with as key drivers to the location decision.

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: Nationality of R&D manager				
Nationality of R&D manager	0,297	0,038	49	Significant at the 0.05 level (2-sided)
Entry: Location choice (key drivers and supporting factors)				
Complementary techn. companies	0,435	0,002	48	Significant at the 0.01 level (2-sided)
Company to collaborate (key driver)	0,358	0,020	42	Significant at the 0.05 level (2-sided)
Presence of parent company	-0,288	0,045	49	Significant at the 0.05 level (2-sided)

Table 78: Variables significantly correlating with key driver 'company to be acquired'

These facilities furthermore noted that complementary technology companies were more important as supporting factors in location decisions than they were to those not citing specific companies to be acquired. The nationality of the facility managers was more likely to be of host country nationality. This may indicate that the acquired companies' managers stayed in their positions under the new ownership of the foreign parent. To facilities that were acquired, a local presence of the parent company was of a lesser importance, leading to the negative correlation in the table, which makes sense taking into account that one of the reasons for acquisition would be the local integration provided by the acquisition candidate.

5.4.2.4 SPECIFIC COMPANY TO COLLABORATE WITH

Those facilities entering a region to specifically collaborate with a company in particular collaborated more actively with key customer collaborations (Table 79).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Integration: Collaboration important to the integration process				
Key customer companies	0,365	0,019	41	Significant at the 0.05 level (2-sided)

Table 79: Variables significantly correlating with key driver 'company to collaborate with'

The data indicates that foreign R&D collaborations are most often key customer company collaborations. In the sense of the MMB model, the data shows that the key customer company-driven motive of R&D internationalization is, from a global perspective especially relevant for those MNC wishing to gain access to knowledge through foreign collaborations.

5.4.2.5 LEADING FOREIGN TECHNOLOGY REGION

The facilities that cited the leading foreign technology region as a key driver to the location decision were more research-driven, more explorative in their nature and grew slower than the companies that attributed less importance to the foreign technology region as a key driver (Table 80).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: R&D mission, growth, explorative vs. exploitative				
Employee growth p.a.	-0,338	0,017	49	Significant at the 0.05 level (2-sided)
R&D mission	-0,364	0,010	49	Significant at the 0.05 level (2-sided)
Explorative vs. exploitative	-0,411	0,004	48	Significant at the 0.01 level (2-sided)
Entry: Location choice (key driver)				
Company to collaborate (key driver)	0,360	0,019	42	Significant at the 0.05 level (2-sided)
Integration: Networks important to the integration process				
Home country mgr personal networks	0,334	0,019	49	Significant at the 0.05 level (2-sided)

Table 80: Variables significantly correlating with key driver 'leading technology region'

They were also more likely to cite a key company to collaborate with as a key location decision driver. Interestingly, these facilities also attributed special importance to home country manager personal networks to activate interfaces to the regional innovation system. The data indicates that integration behavior, from the perspective of the MMB model, may be more independent firm-based for these facilities, characterized by a development-orientation, exploitative knowledge work, and slower growth.

5.4.2.6 IMPORTANT FOREIGN MARKET POTENTIAL

The facilities that attributed greater importance to the leading foreign technology region as a key factor in their location decision, also found a presence of the parent company important, as well as the presence of key supplier/vendor and customer companies (Table 81).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: Size of key partner network				
Size of key partner network	-0,320	0,044	40	Significant at the 0.05 level (2-sided)
Entry: Location choice (supporting factors)				
Presence of parent company	0,483	0,000	49	Significant at the 0.01 level (2-sided)
Key supplier/vendor companies	0,412	0,003	49	Significant at the 0.01 level (2-sided)
Key customer companies	0,407	0,004	49	Significant at the 0.01 level (2-sided)
Attractive local labor market	0,389	0,011	42	Significant at the 0.05 level (2-sided)
Reg. marketing and relocation services	0,374	0,009	48	Significant at the 0.05 level (2-sided)
Cultural proximity to home country	-0,399	0,005	49	Significant at the 0.05 level (2-sided)
Integration: Networks important to the integration process				
Internal PR department network	0,375	0,008	49	Significant at the 0.05 level (2-sided)

Table 81: Variables significantly correlating with key driver 'foreign market potential'

At the 0.05 level of significance, the attractive local labor market and regional marketing and relocation services also played more of a role for these facilities. These facilities used internal PR departments more actively than the facilities that did not cite the leading foreign technology region as a key factor in the location decision. On the other hand, facilities that did not attribute great importance to the leading foreign technology region, at the 0.05 level of significance had larger partner networks and found cultural proximity to be of greater importance in the location choice. From the perspective of the regional typologies, this data particularly reflects the Beijing RIS with its great market potential, add-on R&D facilities and proximity to key customer companies.

5.4.2.7 Attractive local labor market

The facilities that cited the attractive local labor market as a key driver to the location process at the same time named the large scientific labor pool as an important supporting factor in the location process (Table 82).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Entry: Location choice (key drivers and supporting factors)				
Large local labor pool	0,574	0,000	42	Significant at the 0.01 level (2-sided)
Market potential (key driver)	0,389	0,011	42	Significant at the 0.05 level (2-sided)
Gov. financial incentives	0,362	0,022	40	Significant at the 0.05 level (2-sided)
Other international companies	0,349	0,023	42	Significant at the 0.05 level (2-sided)

Table 82: Variables significantly correlating with key driver 'attractive local labor market'

These facilities also named strong state research as an important supporting factor in the location decision, while at the same time showing a stronger interest in the foreign market potential than facilities that did not cite the attractive local labor market as a key location decision driver. Government financial incentives and other international companies in the region were cited as important supporting factors to these facilities as well.

5.4.3 Supporting factors of global location decisions

5.4.3.1 LARGE TARGET MARKET

The data shows that large target market and large target market growth as supporting factors in the location decision correlate fairly strongly (Table 83).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: Collaborative vs. proprietary				
Collaborative vs. proprietary	-0,269	0,043	57	Significant at the 0.05 level (2-sided)
Entry: Location choice (key drivers and supporting factors)				
Large market growth	0,745	0,000	60	Significant at the 0.01 level (2-sided)
Key customer companies	0,505	0,000	60	Significant at the 0.01 level (2-sided)
Market potential	0,330	0,021	49	Significant at the 0.05 level (2-sided)
Presence of parent company	0,310	0,016	60	Significant at the 0.05 level (2-sided)

Table 83: Variables significantly correlating with supporting factor 'large target market'

Furthermore, companies citing market size as an important supporting factor in the location process also valued key customer companies at the location. A presence of the parent company also played a role, while facilities seeking large target markets were more collaborative than those that did not.

5.4.3.2 LARGE TARGET MARKET GROWTH

At the 0.01 level of significance, facilities citing large target market growth as a supporting factor in the location decision also found large overall markets, and the presence of key customer and competitor companies important (Table 84).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: Nationality of R&D manager				
Nationality of R&D manager	-0,267	0,039	60	Significant at the 0.05 level (2-sided)
Entry: Location choice (key drivers and supporting factors)				
Large target market	0,745	0,000	60	Significant at the 0.01 level (2-sided)
Key customer companies	0,368	0,004	60	Significant at the 0.01 level (2-sided)
Key competitor companies	0,356	0,005	60	Significant at the 0.01 level (2-sided)
Market potential (key driver)	0,353	0,013	49	Significant at the 0.05 level (2-sided)

Table 84: Variables significantly correlating with supporting factor 'large market growth'

The only negative correlation was with the nationality of R&D manager variable, indicating that facilities valuing high-growth locations preferred to home country nationality management. This confirms the earlier insight that fast facilities in fast growing (turbulent) regions are more often lead by home country nationality managers and are thus more independent firm-based in the sense of the MMB model.

5.4.3.3 STRONG UNIVERSITY RESEARCH

The positive correlations indicate that facilities with an interest in strong university research were also interested in state research, the R&D environment, single university institutes, and the public infrastructure in the context of their location decisions (Table 85).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: R&D mission, explorative vs. exploitative				
Explorative vs. exploitative	-0,488	0,000	58	Significant at the 0.01 level (2-sided)
R&D mission	-0,638	0,000	60	Significant at the 0.01 level (2-sided)
Entry: Location choice (key drivers, supporting factors, character of the location choice)				
Strong state research	0,711	0,000	59	Significant at the 0.01 level (2-sided)
R&D environment	0,518	0,000	60	Significant at the 0.01 level (2-sided)
Single univ. institute (key driver)	0,477	0,001	49	Significant at the 0.01 level (2-sided)
Public infrastructure	0,331	0,010	60	Significant at the 0.01 level (2-sided)
Character of location choice	-0,422	0,001	57	Significant at the 0.01 level (2-sided)
Integration: Collaboration important to the integration process				
Universities	0,573	0,000	58	Significant at the 0.01 level (2-sided)
Lead customer companies	-0,398	0,002	59	Significant at the 0.01 level (2-sided)
Integration: Networks important to the integration process				
Employee personal networks	0,448	0,000	59	Significant at the 0.01 level (2-sided)
Non-industrial club networks	0,427	0,001	59	Significant at the 0.01 level (2-sided)
Gov. matchmaking networks	0,411	0,001	59	Significant at the 0.01 level (2-sided)
Open non-industrial networks	0,403	0,002	59	Significant at the 0.01 level (2-sided)

Table 85: Variables significantly correlating with supporting factor 'university research'

In terms of collaborations, they favored university collaborations. The networks that were of importance to these facilities were employee personal networks, non-industrial club networks, government matchmaking networks, and open non-industrial networks.

The negative correlations indicate that facilities that did not consider strong university research as important, found lead customer collaborations more important, had location decisions that were more lengthy/analytical than intuitive/emotional, followed exploitative knowledge aims, and were mode development- than research driven. This insight constitutes that the market- versus S&T-driven motives described in the MMB model have a global relevance, thus supporting the validity of the model.

5.4.3.4 STRONG STATE RESEARCH

The positive correlations at the 0.01 level of significance in the table show that facilities favoring strong state research also sought strong university research and government financial incentives in their location decisions (Table 86).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: R&D mission				
R&D mission	-0,405	0,001	59	Significant at the 0.01 level (2-sided)
Entry: Location choice (key drivers, supporting factors, character of the location choice)				
Strong university research	0,711	0,000	59	Significant at the 0.01 level (2-sided)
Gov. financial incentives	0,428	0,001	57	Significant at the 0.01 level (2-sided)
Large scientific labor pool	0,421	0,001	59	Significant at the 0.05 level (2-sided)
R&D environment	0,418	0,001	59	Significant at the 0.01 level (2-sided)
Public transport infrastructure	0,416	0,001	59	Significant at the 0.01 level (2-sided)
Attractive labor market (key driver)	0,335	0,030	42	Significant at the 0.05 level (2-sided)
Character of location choice	-0,341	0,010	56	Significant at the 0.05 level (2-sided)
Integration: Collaboration important to the integration process				
Universities	0,343	0,009	57	Significant at the 0.01 level (2-sided)
State research labs	0,587	0,000	57	Significant at the 0.01 level (2-sided)
Integration: Networks important to the integration process				
Gov. matchmaking networks	0,531	0,000	58	Significant at the 0.01 level (2-sided)

Table 86: Variables significantly correlating with supporting factor 'strong state research'

They also found the R&D environment and the public transport infrastructure to be of greater importance. In terms of networking, they were especially active in government matchmaking networks. At the 0.05 level of significance, large scientific labor pool and the attractive local labor market also played more important roles to facilities that favored strong state research. The negative correlations indicate that facilities giving less priority to strong state research were more development-driven, conducted location decisions that were more emotional/intuitive than lengthy/analytical, and were less prone to collaborate with competitor companies outside the host country.

5.4.3.5 LARGE LOCAL LABOR POOL

The positive correlations at the 0.01 level of significance in Table 87 indicate that facilities favoring a large scientific labor pool also sought an attractive local labor market and proximity to other international companies, and were active in open industrial networks.

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Entry: Location choice (supporting factors in the location decision)				
Attractive labor market	0,574	0,000	42	Significant at the 0.01 level (2-sided)
Strong state research	0,421	0,001	59	Significant at the 0.05 level (2-sided)
R&D environment	0,356	0,005	60	Significant at the 0.05 level (2-sided)
Other international companies	0,345	0,007	60	Significant at the 0.01 level (2-sided)
Integration: Networks important in the integration process				
Open industrial networking	0,358	0,005	59	Significant at the 0.01 level (2-sided)

Table 87: Variables significantly correlating with supporting factor 'scientific labor pool'

The correlations at the 0.05 level of significance indicate that these facilities furthermore favored strong state research and a favorable R&D environment in their location decisions.

5.4.3.6 KEY CUSTOMER COMPANIES

Facilities that sought proximity to key customer companies in their foreign location decisions were also more interested in lead customer collaborations (Table 88).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: R&D mission				
R&D mission	0,426	0,001	60	Significant at the 0.01 level (2-sided)
Entry: Location choice (key drivers and supporting factors)				
Large target market	0,505	0,000	60	Significant at the 0.01 level (2-sided)
Market potential (key driver)	0,407	0,004	49	Significant at the 0.01 level (2-sided)
Large target market growth	0,368	0,004	60	Significant at the 0.01 level (2-sided)
Single university institute (key driver)	-0,288	0,045	49	Significant at the 0.05 level (2-sided)
Strong university research	-0,319	0,013	60	Significant at the 0.05 level (2-sided)
Integration: Collaboration important to the integration process				
Lead customer company collab.	0,588	0,000	59	Significant at the 0.01 level (2-sided)

Table 88: Variables significantly correlating with supporting factor 'customer companies'

The R&D mission correlation shows that these facilities were more development- than research-driven. Furthermore, they were attracted by local market potential and large target market growth. Correlations at the 0.05 level of significance furthermore show that facilities seeking proximity to key customer companies also collaborated more actively with supplier/vendor companies. The two negative correlations indicate that key company-seeking facilities did not seek single university institutes or strong university research in their location decisions. From the perspective of the MMB model, this data shows that not only market-driven but also key customer company-driven motives for the internationalization of R&D are attracted by large, fast growing target markets.

5.4.3.7 KEY SUPPLIER/VENDOR COMPANIES

Facilities seeking proximity to key supplier/vendor companies in their location decisions found market potential, regional marketing and relocation services, and the presence of other international companies more important in the location decisions than facilities not seeking proximity to supplier/vendor companies (Table 89).

Independent variables	**Pearson Correlation**	**Significance (2-sided)**	**N**	**Significance Level**
Entry: Location choice (key drivers and supporting factors)				
Market potential (key driver)	0,412	0,003	49	Significant at the 0.01 level (2-sided)
Marketing and relocation services	0,378	0,003	59	Significant at the 0.01 level (2-sided)
Other international companies	0,350	0,006	60	Significant at the 0.01 level (2-sided)
Single scientist (key driver)	-0,317	0,027	49	Significant at the 0.05 level (2-sided)

Table 89: Variables significantly correlating with supp. factor 'supplier/vendor companies'

The negative correlation with the single scientist variable indicates that facilities seeking single scientists as key determinants in their location decisions sought less proximity to supplier/vendor companies than those facilities that did not.

5.4.3.8 KEY COMPLEMENTARY TECHNOLOGY COMPANIES

Facilities seeking proximity to key complementary technology companies were also more active in industrial club networks than facilities not seeking proximity to key complementary technology companies (Table 90).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Entry: Location decision (key drivers and supporting factors)				
R&D environment	0,381	0,003	60	Significant at the 0.01 level (2-sided)
Marketing and relocation services	0,350	0,007	59	Significant at the 0.01 level (2-sided)
Key competitor companies	0,351	0,006	60	Significant at the 0.05 level (2-sided)
Integration: Networks important in the integration process				
Industrial club networks	0,463	0,000	59	Significant at the 0.01 level (2-sided)

Table 90: Variables significantly correlating with supporting factor 'complementary technology companies'

In their location decisions, they paid special attention to the R&D environment, the presence of key competitor companies, and regional marketing and relocation services.

5.4.3.9 KEY COMPETITOR COMPANIES

Similar to the above findings, facilities seeking proximity to key competitor companies in their location decisions, were more active in industrial club networks, and attributed special importance to the R&D environment as well as regional marketing and relocation services (Table 91).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Entry: Location decision (supporting factors)				
R&D environment	0,381	0,003	60	Significant at the 0.01 level (2-sided)
Marketing and relocation services	0,350	0,007	59	Significant at the 0.01 level (2-sided)
Integration: Networks important in the integration process				
Industrial club netw.	0,463	0,000	59	Significant at the 0.01 level (2-sided)

Table 91: Variables significantly correlating with 'key competitor companies'

5.4.3.10 R&D ENVIRONMENT

Facilities seeking a strong R&D environment in their location choice at the 0.01 level of significance also sought strong university and state research, a large scientific labor pool, a favorable government and administrative environment, and the presence of complementary technology companies (Table 92).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: R&D mission, explorative vs. exploitative				
R&D mission	-0,385	0,002	60	Significant at the 0.01 level (2-sided)
Explorative vs. exploitative	-0,388	0,003	58	Significant at the 0.01 level (2-sided)
Entry: Location decision (key drivers and supporting factors)				
Strong university research	0,518	0,000	60	Significant at the 0.01 level (2-sided)
Strong state research	0,418	0,001	59	Significant at the 0.01 level (2-sided)
Complementary technology companies	0,381	0,003	60	Significant at the 0.01 level (2-sided)
Large scientific labor pool (key driver)	0,356	0,005	60	Significant at the 0.01 level (2-sided)
Gov. and administrative environment	0,340	0,008	59	Significant at the 0.01 level (2-sided)
Local experience of lab mgr	0,336	0,009	60	Significant at the 0.01 level (2-sided)
Integration: Collaboration important to the integration process				
Universities	0,332	0,011	58	Significant at the 0.05 level (2-sided)
Integration: Networks important in the integration process				
Open non-industrial networks	0,371	0,004	59	Significant at the 0.05 level (2-sided)
Empl. personal networks	0,338	0,009	59	Significant at the 0.05 level (2-sided)

Table 92: Variables significantly correlating with supporting factor 'R&D environment'

The local experience of the designated lab manager was also more important in these facilities' location decisions. At the 0.05 level of significance, open non-industrial networks, employee personal networks, and university collaborations also played more important roles for facilities seeking a strong R&D environment than for those that did not. The negative correlation with R&D mission indicates that facilities seeking strong R&D environments were more research- than development-driven, the negative correlation with the explorative/exploitative variable indicating that they were furthermore explorative in their nature. From the perspective of the MMB model, these facilities are strongly S&T-driven in their motive for R&D internationalization.

5.4.3.11 Government and administrative environment

Those citing government and administrative environment as an important supporting factor in the location decision also sought government financial incentives and external government matchmaking networks, as well as more actively employing R&D managers' and R&D employees' personal networks (Table 93).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Entry: Location decision (supporting factors)				
Gov. financial incentives	0,445	0,001	57	Significant at the 0.01 level (2-sided)
R&D environment	0,340	0,008	59	Significant at the 0.01 level (2-sided)
Strong state research	0,316	0,016	58	Significant at the 0.05 level (2-sided)
Integration: Networks important for the integration process				
Employee personal networks	0,361	0,005	58	Significant at the 0.01 level (2-sided)
Gov. matchmaking networks	0,339	0,009	58	Significant at the 0.01 level (2-sided)
Manager personal networks	0,337	0,010	58	Significant at the 0.01 level (2-sided)

Table 93: Variables significantly correlating with supporting factor 'gov. and administrative environment'

They furthermore found the R&D environment to be of greater importance as a supporting factor in the location decision than facilities not seeking favorable government and administrative environments. The correlation at the 0.05 level of significance shows that these facilities furthermore found state research to be an important supporting factor in the location decision.

5.4.3.12 Presence of the parent company

Facilities that found a local presence of the parent company an important supporting factor in the location decision also found foreign market potential and the presence of other companies from the home country, as well as other international companies more important than facilities that did not seek proximity to the parent company (Table 94).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Entry: Location decision (key drivers and supporting factors)				
Market potential (key driver)	0,483	0,000	49	Significant at the 0.01 level (2-sided)
Other companies from home country	0,458	0,000	59	Significant at the 0.01 level (2-sided)
Other international companies	0,433	0,001	60	Significant at the 0.01 level (2-sided)
Gov. financial incentives	0,359	0,006	58	Significant at the 0.01 level (2-sided)
Company to be acquired (key driver)	-0,288	0,045	49	Significant at the 0.05 level (2-sided)
Integration: Networks important for the integration process				
Gov. matchmaking networks	0,324	0,012	59	Significant at the 0.05 level (2-sided)

Table 94: Variables significantly correlating with supporting factor 'presence of parent company'

Likewise, they found government financial incentives and government matchmaking networks more important than facilities not seeking proximity to the parent company abroad. The negative correlation implies that facilities not seeking proximity to the parent company are more likely to be founded by way of acquisition than facilities seeking proximity to the parent company. The data, from the perspective of the MMB model, indicates that R&D facilities located in proximity of the parent company, relating to market-driven motives for the internationalization of R&D, also seek a local population of other international companies.

5.4.3.13 Local experience of lab manager

Facilities that sought local experience of the designated manager of the R&D facility in their location decisions at the same time sought single scientists as key factors in the location decision, and were interested in a favorable R&D environment when choosing their location (Table 95).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: Explorative vs. exploitative				
Explorative vs. exploitative	-0,310	0,018	58	Significant at the 0.05 level (2-sided)
Entry: Location choice (key drivers and supporting factors)				
Single scientist (key driver)	0,436	0,002	49	Significant at the 0.01 level (2-sided)
R&D environment	0,336	0,009	60	Significant at the 0.01 level (2-sided)
Integration: Networks important for the integration process				
Mgr. personal networks	0,325	0,012	59	Significant at the 0.05 level (2-sided)

Table 95: Variables significantly correlating with supporting factor 'local experience of lab manager'

They were furthermore considered the personal networks of the facility's management to be more important than facilities that did not seek local experience of the designated lab manager. The negative correlation indicates that facilities seeking locations where designated management has local experience were more explorative than exploitative. From the perspective of the MMB model, this clearly indicates the S&T-driven motive for R&D internationalization.

5.4.3.14 CULTURAL PROXIMITY

Facilities looking for cultural proximity at their foreign location were also more active collaborating with competitor companies and conducted location decisions that were more intuitive/emotional than lengthy/analytical in their nature (Table 96).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: Size at founding				
R&D employees at founding	0,339	0,009	58	Significant at the 0.01 level (2-sided)
Entry: Location decision (key drivers and supporting factors)				
Character of location choice	0,343	0,009	57	Significant at the 0.01 level (2-sided)
Market potential (key driver)	-0,399	0,005	49	Significant at the 0.01 level (2-sided)
Gov. & administrative environment	0,262	0,045	59	Significant at the 0.05 level (2-sided)
Integration: Collaboration important for the integration process				
Competitor companies	0,407	0,001	59	Significant at the 0.01 level (2-sided)
Integration: Networks important for the integration process				
Headhunter networks	0,271	0,038	59	Significant at the 0.05 level (2-sided)

Table 96: Variables significantly correlating with supporting factor 'cultural proximity'

Their size at founding was larger than that of companies not specifically seeking cultural proximity, and they favored regions with favorable government and administrative environments while using headhunter networks more frequently than facilities not seeking locations specifically for their cultural proximity.

5.4.3 Conclusion on global entry behavior of R&D facilities

The data on key drivers and supporting factors in location decisions supports the global validity of the MMB model within the sample. Pearson correlations, as presented in the tables, indicate that facilities with research- versus development-driven R&D missions throughout the sample have similar characteristics, while the same goes for market- versus S&T-, cost- and key customer company-driven motives for the internationalization of R&D.

5.5 The global integration behavior of R&D

5.5.1 Introduction

The above two chapters examined global patterns in the characteristics and the entry behavior of foreign-owned R&D facilities in order to gather data giving global validity and further refinement to the MMB model. The following section will go on to examine global patterns in the integration behavior of these facilities. To do so, collaboration partners and networks used to access regional knowledge resources are examined.

5.5.2 Collaboration partners

5.5.2.1 UNIVERSITIES

Universities as collaboration partners were especially important to facilities seeking proximity to key customer companies and those facilities that collaborated more actively with customer and supplier/vendor companies (Table 97).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: R&D mission, explorative vs. exploitative				
R&D mission	0,513	0,000	59	Significant at the 0.01 level (2-sided)
Explorative vs. exploitative	0,418	0,001	58	Significant at the 0.01 level (2-sided)
Entry: Location decision (key drivers and supporting factors)				
Key customer companies	0,588	0,000	59	Significant at the 0.01 level (2-sided)
Co. to collaborate (key driver)	0,365	0,019	41	Significant at the 0.01 level (2-sided)
Strong university research	-0,398	0,002	59	Significant at the 0.01 level (2-sided)
University institute (key driver)	-0,371	0,010	48	Significant at the 0.01 level (2-sided)
Integration: Collaboration important for the integration process				
Supplier/vendor companies	0,394	0,002	59	Significant at the 0.01 level (2-sided)
Integration: Networks important for the integration process				
Industrial club networks	0,370	0,004	58	Significant at the 0.01 level (2-sided)
Consultant networks	0,312	0,017	58	Significant at the 0.05 level (2-sided)

Table 97: Variables significantly correlating with collaboration partner 'universities'

These facilities were more development- than research-driven and were more exploitative than explorative in their nature. Industrial club and consultant networks were used more actively by these facilities than by facilities not collaborating as actively with universities. This leads back to the distinction between (1) research-driven, and (2) recruitment-driven university collaboration types. The positive correlations in Table 97 clearly point towards recruitment-driven university collaborations that dominate the global sample. The two negative correlations confirm this by indicating that facilities that collaborated strongly with universities were less interested in single university institutes or strong university research.

5.5.2.2 STATE R&D LABS

Those facilities collaborating actively with state R&D labs also sought state research in their location decisions (Table 98).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Entry: Location choice (supporting factors)				
Strong state research	0,587	0,000	57	Significant at the 0.01 level (2-sided)
Public transport infrastructure	0,351	0,007	58	Significant at the 0.01 level (2-sided)
Strong university research	0,272	0,039	58	Significant at the 0.05 level (2-sided)
Gov. & administrative environment	0,291	0,028	57	Significant at the 0.05 level (2-sided)
Gov. financial incentives	0,297	0,026	56	Significant at the 0.05 level (2-sided)
Integration: Collaboration important to the integration process				
Universities	0,378	0,003	58	Significant at the 0.01 level (2-sided)
Integration: Networks important to the integration process				
Gov. matchmaking networks	0,447	0,000	58	Significant at the 0.01 level (2-sided)

Table 98: Variables significantly correlating with collaboration partner 'state R&D labs'

They also used government matchmaking networks more actively than facilities not collaborating as much with state R&D labs and collaborated more actively with universities. They furthermore considered public transportation infrastructure, government financial incentives, a positive government and administrative environment, and strong university research as more important in their location decisions than facilities not collaborating as actively with state research labs. From the perspective of the MMB model, these facilities correspond to facility types that are research-driven in terms of mission and S&T-driven in terms of their motive.

5.5.2.3 KEY CUSTOMER COMPANIES

Facilities actively collaborating with key customer companies also sought these companies in their location decisions. They were more development- than research-driven and were more exploitative than explorative (Table 99).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: R&D mission, explorative vs. exploitative				
R&D mission	0,513	0,000	59	Significant at the 0.01 level (2-sided)
Explorative vs. exploitative	0,418	0,001	58	Significant at the 0.01 level (2-sided)
Entry: Location choice (key drivers and supporting factors)				
Key customer companies	0,588	0,000	59	Significant at the 0.01 level (2-sided)
Company to collaborate (key driver)	0,365	0,019	41	Significant at the 0.01 level (2-sided)
Strong university research	-0,398	0,002	59	Significant at the 0.01 level (2-sided)
University institute (key driver)	-0,371	0,010	48	Significant at the 0.01 level (2-sided)
Integration: Collaboration important to the integration process				
Supplier/vendor companies	0,394	0,002	59	Significant at the 0.01 level (2-sided)
Integration: Networks important to the integration process				
Industrial club networks	0,370	0,004	58	Significant at the 0.01 level (2-sided)
Consultant networks	0,312	0,017	58	Significant at the 0.05 level (2-sided)

Table 99: Variables significantly correlating with collaboration partner 'key customer companies'

They furthermore collaborated more actively with supplier/vendor companies than facilities not collaborating with key customer companies as actively. Their location decisions were more often driven mainly by the wish to collaborate with a company in the foreign region. These facilities used industrial club and consultant networks more actively as well. The negative correlations indicate that they however did not seek individual university institutes nor were they principally interested in strong local university research when conducting their location decisions. From the perspective of the MMB model, the collaborative approach indicates network-based entry behavior, while the rest of the data indicates that key customer company-driven motives of facilities are more often than not development-driven in terms of their motives and exploitative in the character of their knowledge work.

5.5.2.4 SUPPLIER/VENDOR COMPANIES

Facilities that collaborated actively with supplier/vendor companies were more development- than research-driven, and more exploitative than explorative in their nature. They also collaborated more actively with complementary and key customer companies than facilities not as actively collaborating with supplier/vendor companies (Table 100).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: R&D mission, explorative vs. exploitative				
R&D mission	0,425	0,001	59	Significant at the 0.01 level (2-sided)
Explorative vs. exploitative	0,316	0,016	58	Significant at the 0.05 level (2-sided)
Entry: Location decision (key drivers and supporting factors)				
Strong university research	-0,329	0,011	59	Significant at the 0.05 level (2-sided)
University institute (key driver)	-0,346	0,016	48	Significant at the 0.05 level (2-sided)
Integration: Collaboration important to the integration process				
Lead customer companies	0,394	0,002	59	Significant at the 0.01 level (2-sided)
Complementary tech. companies	0,327	0,012	59	Significant at the 0.05 level (2-sided)

Table 100: Variables significantly correlating with collaboration partner 'supplier/vendor companies'

Negative collaborations indicate that neither single university institutes nor strong local university research played overriding roles in the facilities' location decisions. From the perspective of the MMB model, these facilities were however S&T-driven due to the technological nature of this collaboration partner type.

5.5.2.5 COMPLEMENTARY TECHNOLOGY COMPANIES

Those that collaborated more actively with complementary technology companies also sought key competitor companies in their location decisions, and were likely to have been founded in the form of a foreign acquisition (Table 101).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: R&D mission				
R&D mission	0,292	0,025	59	Significant at the 0.05 level (2-sided)
Entry: Location decision (key drivers and supporting factors, character of location choice)				
Key competitor companies	0,446	0,000	59	Significant at the 0.01 level (2-sided)
Company to be acquired (key driver)	0,435	0,002	48	Significant at the 0.01 level (2-sided)
Character of location choice	0,402	0,002	56	Significant at the 0.01 level (2-sided)
Strong university research	-0,290	0,026	59	Significant at the 0.05 level (2-sided)
Single scientist (key driver)	-0,312	0,031	48	Significant at the 0.05 level (2-sided)
Integration: Collaboration important to the integration process				
Supplier/vendor companies	0,327	0,012	59	Significant at the 0.05 level (2-sided)
Lead customer companies	0,268	0,040	59	Significant at the 0.05 level (2-sided)
Integration: Networks important to the integration process				
Open non-industrial networks	-0,278	0,035	58	Significant at the 0.05 level (2-sided)
Empl. personal networks	-0,308	0,019	58	Significant at the 0.05 level (2-sided)

Table 101: Variables significantly correlating with collaboration partner 'complementary technology companies'

The character of their location choices was thus (due to the acquisitions) more intuitive/emotional than lengthy/analytical. Their R&D missions were more development- than research-driven and they collaborated more actively with supplier/vendor and key customer companies than facilities not as actively collaborating with complementary technology companies. Negative correlations indicate that these facilities found open non-industrial networks and employee personal networks less important than the facilities collaborating less actively with complementary technology companies and found strong university research and single scientists in the foreign region less critical in the location decision. From the perspective of the MMB model, once again, these facilities are assumed to be S&T-driven in their motive due to the technological character of complementary technology companies.

5.5.2.6 Competitor companies

The only variable with a positive correlation at the 0.01 level of significance is cultural proximity, indicating that competitor collaborations, if undertaken, are undertaken similarity of cultures reduces the uncertainty in the collaboration process (Table 102).

Independent variables (Competitor companies)	Pearson Correlation	Significance (2-sided)	N	Significance Level
Entry: Location decision (key drivers and supporting factors)				
Cultural proximity	0,407	0,001	59	Significant at the 0.01 level (2-sided)
Character of location choice	0,336	0,011	56	Significant at the 0.05 level (2-sided)
Local labor market (key driver)	-0,263	0,096	41	Significant at the 0.05 level (2-sided)
Integration: Collaboration important to the integration process				
Complementary techn companies	0,329	0,011	59	Significant at the 0.05 level (2-sided)
Key customer companies	0,277	0,034	59	Significant at the 0.05 level (2-sided)
Integration: Networks important to the integration process				
Consultant networks	0,303	0,021	58	Significant at the 0.05 level (2-sided)
Open non-industrial networks	-0,303	0,021	58	Significant at the 0.05 level (2-sided)

Table 102: Variables significantly correlating with collaboration partner 'competitor companies'

The positive correlation with character of location choice shows that they were more intuitive/emotional than lengthy/analytical. Collaborations with complementary technology companies and lead customer companies were also more frequent for these facilities. They were also more active in consultant networks. Negative correlations indicate that facilities collaborating with competitors were less interested in an attractive local labor market and were less active in open non-industrial networks. Since competitor collaborations were extremely rare in the sample, there is no use in deducting conclusions for the MMB model.

5.5.3 Networks

5.5.3.1 R&D MANAGER PERSONAL NETWORKS

At the 0.01 level of significance, the data indicates that strong manager personal networks are seen as especially important where great value is also given to employee personal networks and where the government and administrative environment played important roles in the foreign facilities' location decisions (Table 103).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: Nationality of R&D manager, growth				
Nationality of R&D manager	0,323	0,013	59	Significant at the 0.05 level (2-sided)
Employee growth p.a.	-0,281	0,034	57	Significant at the 0.05 level (2-sided)
Entry: Location decision (key drivers and supporting factors)				
Gov. & admin. environment	0,337	0,010	58	Significant at the 0.01 level (2-sided)
Local experience of R&D mgr	0,325	0,012	59	Significant at the 0.05 level (2-sided)
University institute (key driver)	0,312	0,029	49	Significant at the 0.05 level (2-sided)
Integration: Networks important for the integration process				
Employee personal networks	0,450	0,000	59	Significant at the 0.01 level (2-sided)
Open industrial networks	0,285	0,029	59	Significant at the 0.05 level (2-sided)
Gov. matchmaking networks	0,280	0,032	59	Significant at the 0.05 level (2-sided)

Table 103: Variables significantly correlating with network 'manager personal networks'

At the 0.05 level of significance strong manager personal networks are seen as important where the local experience of the designated manager was important for the location decision, and in cases where the manager was of host country nationality. This was also the case where single university institutes were key drivers in the location decision, and where open industrial and government matchmaking networks were important. The facilities that judge manager personal networks as important grew less quickly than facilities that did not find them as important. From the perspective of the MMB model, the data indicates that network-based integration behavior, which by definition requires strong manager personal networks, is more frequent when host country nationality management is employed.

5.5.3.2 R&D EMPLOYEE PERSONAL NETWORKS

Facilities judging employee personal networks as especially important also found manager personal networks to be important (Table 104). They were furthermore more influenced in their location decisions by the presence of strong university and state research and were more active collaborating with universities than facilities finding employee networks less important.

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: R&D mission, growth, explorative vs. exploitative				
Explorative vs. exploitative	-0,281	0,034	57	Significant at the 0.05 level (2-sided)
Employee growth p.a.	-0,370	0,005	57	Significant at the 0.01 level (2-sided)
R&D mission	-0,461	0,000	59	Significant at the 0.01 level (2-sided)
Entry: Location choice (supporting factors)				
Strong university research	0,448	0,000	59	Significant at the 0.01 level (2-sided)
Government and admin. environment	0,361	0,005	58	Significant at the 0.01 level (2-sided)
R&D environment	0,338	0,009	59	Significant at the 0.01 level (2-sided)
Strong state research	0,286	0,030	58	Significant at the 0.05 level (2-sided)
Integration: Collaboration important to the integration process				
Universities	0,421	0,001	58	Significant at the 0.01 level (2-sided)
Complementary techn. companies	-0,308	0,019	58	Significant at the 0.05 level (2-sided)
Integration: Networks important to the integration process				
Mgr. personal networks	0,450	0,000	59	Significant at the 0.01 level (2-sided)
Open industrial networks	0,361	0,005	59	Significant at the 0.01 level (2-sided)

Table 104: Variables significantly correlating with network 'employee personal networks'

The government and administrative environments as well as the general R&D environment were more important to these facilities as well, while they were more active in open industrial networks. The negative correlations indicate that the facilities that attributed special relevance to employee personal networks were more explorative than exploitative in their orientation, and more research- than development-driven. They grew slower than facilities finding employee personal networks less important and collaborated less with complementary technology companies. From the perspective of the MMB model, the data indicates that research-driven, explorative facilities show greater priority in employee personal networks, making them more liable to conduct network-based integration behavior.

5.5.3.3 Internal human resources department networks

Facilities that found their internal human resources departments to be especially important to activate interfaces to the regional innovation system also used internal and external public relations and advertising activities to gain access and integrate with the regional innovation system (Table 105).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Integration: Networks important to the integration process				
Lab PR networks	0,655	0,000	59	Significant at the 0.01 level (2-sided)
PR firm networks	0,375	0,003	59	Significant at the 0.01 level (2-sided)
Ad agency networks	0,334	0,010	59	Significant at the 0.01 level (2-sided)
Open non-industrial networks	0,331	0,010	59	Significant at the 0.05 level (2-sided)
Industrial club networks	0,314	0,016	59	Significant at the 0.05 level (2-sided)
Open industrial networks	0,300	0,021	59	Significant at the 0.05 level (2-sided)

Table 105: Variables significantly correlating with network 'internal HR departments'

These facilities were also more active in non-industrial and industrial open and club networks than facilities making less use of internal HR departments as regional networking tools. No implications are derived for the MMB model from this data.

5.5.3.4 INTERNAL PUBLIC RELATIONS DEPARTMENT NETWORKS

Positive correlations indicate that facilities judging internal PR departments as important for regional networking also employ internal HR departments and external PR firms, as well as external advertising agencies more often than facilities that find internal PR less important (Table 106).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: Collaborative vs. proprietary, tacit vs. explicit				
Tacit vs. explicit	0,340	0,010	57	Significant at the 0.01 level (2-sided)
Collaborative vs. proprietary	0,310	0,019	57	Significant at the 0.05 level (2-sided)
Entry: Location choice (key driver)				
Foreign market potential (key driver)	0,375	0,008	49	Significant at the 0.01 level (2-sided)
Integration: Networks important to the integration process				
Lab HR networks	0,655	0,000	59	Significant at the 0.01 level (2-sided)
Ad agency networks	0,354	0,006	59	Significant at the 0.01 level (2-sided)
PR firm networks	0,506	0,000	59	Significant at the 0.01 level (2-sided)
Industrial club networks	0,345	0,007	59	Significant at the 0.01 level (2-sided)

Table 106: Variables significantly correlating with network 'internal PR departments'

These facilities also found the foreign market potential to be a key driver in their location decisions, while they were more active in industrial club networks. The character of their knowledge work tended towards explicit and proprietary work rather than tacit and collaborative work. No meaningful implications can be derived for the MMB model from this data.

5.5.3.5 HOME COUNTRY MANAGERS' PERSONAL NETWORKS

Positive correlations indicate that facilities favoring home country manager personal networks also used host country non-R&D manager personal networks to integrate with the regional innovation system (Table 107).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Entry: Location choice (key drivers and supporting factors)				
Foreign techn. region (key driver)	0,334	0,019	49	Significant at the 0.05 level (2-sided)
Gov. financial incentives	0,280	0,036	56	Significant at the 0.05 level (2-sided)
Gov. and administrative environment	0,262	0,049	57	Significant at the 0.05 level (2-sided)
Host non-R&D mgr personal networks	0,419	0,001	58	Significant at the 0.01 level (2-sided)
Gov. matchmaking networks	0,372	0,004	58	Significant at the 0.01 level (2-sided)

Table 107: Variables significantly correlating with network 'home country manager networks'

They furthermore activated government matchmaking networks and were influenced in their location decisions by government financial incentives, the general government and administrative environment more so than facilities not as active with home country manager personal networks. These facilities' location decisions were furthermore determined by the quality of the foreign technology region.

The emerging insight that integration can be pursued as a top-down process (involving high level home country managers and government officials) or a bottom-up process (involving R&D lab employees and local knowledge carriers), leads to distinguish between two types of integration behavior: (1) high-level strategic integration, and (2) day-to-day operational integration.

5.5.3.6 HOST COUNTRY NON-R&D MANAGERS' PERSONAL NETWORKS

Facilities employing host country non-R&D manager networks also used home country manager personal networks as well as external PR firms to facilitate integration more so than facilities not using host country non-R&D manager networks as actively (Table 108).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Entry: Location decision (key driver)				
Single scientist (key driver)	-0,286	0,046	49	Significant at the 0.05 level (2-sided)
Integration: Networks important to the integration process				
Home country mgr personal networks	0,419	0,001	58	Significant at the 0.01 level (2-sided)
PR firm networks	0,351	0,006	59	Significant at the 0.01 level (2-sided)

Table 108: Variables significantly correlating with network 'host country non-R&D mgr. networks'

They were at the same time less likely to be driven to locate in the region due to a single key scientist. This indicates that integration behavior leveraging host-country non-R&D networks may more often than not be market- or key customer company-driven rather than S&T-driven.

5.5.3.7 CONSULTANT NETWORKS

The positive correlations indicate that facilities employing consultants were more likely to enter into a region with the primary aim of collaborating with another company than facilities not using consultant networks as actively (Table 109).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Entry: Location decision (key driver)				
Company to collaborate (key driver)	0,335	0,030	42	Significant at the 0.05 level (2-sided)
Integration: Collaboration important to the integration process				
Lead customer companies	0,312	0,017	58	Significant at the 0.05 level (2-sided)
Competitor companies	0,303	0,021	58	Significant at the 0.05 level (2-sided)

Table 109: Variables significantly collaborating with network 'consultant networks'

They were also more active in collaborating with lead customer and competitor companies. Thus in the sense of the MMB model, network-based integration behavior is supported by consultant integration facilitation.

5.5.3.8 GOVERNMENT MATCHMAKING NETWORKS

The positive correlations at the 0.01 level of significance indicate that facilities more active in government matchmaking networks based their location choices more strongly on a local presence of strong state research, public transport infrastructure. university research, the presence of other international companies, and a generally favorable government and administrative environment (Table 110).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: R&D mission				
R&D mission	-0,271	0,038	59	Significant at the 0.05 level (2-sided)
Entry: Location choice (supporting factors)				
Strong state research	0,531	0,000	58	Significant at the 0.01 level (2-sided)
Public transport infrastructure	0,501	0,000	59	Significant at the 0.01 level (2-sided)
State research labs	0,447	0,000	58	Significant at the 0.01 level (2-sided)
Strong univ. research	0,411	0,001	59	Significant at the 0.01 level (2-sided)
Gov. and administrative environment	0,339	0,009	58	Significant at the 0.01 level (2-sided)
Integration: Collaboration important to the integration process				
Other international companies	0,339	0,009	59	Significant at the 0.05 level (2-sided)
Integration: networks important to the integration process				
Home country mgr personal networks	0,372	0,004	58	Significant at the 0.01 level (2-sided)
Non-industrial club networks	0,354	0,006	59	Significant at the 0.01 level (2-sided)

Table 110: Variables significantly correlating with network 'government matchmaking networks'

They were more likely to collaborate with state research labs and more actively employed home country manager personal networks and non-industrial club networks than facilities not as actively using government matchmaking networks. The negative correlation with R&D mission indicates that the facilities using government matchmaking were more research- than development-driven. From the perspective of the MMB model, the data on factors indicating the location choice indicates that the facilities using government matchmaking networks were mainly S&T-driven.

5.5.3.9 Headhunter networks

Facilities using headhunters have a more proprietary approach to R&D, while more actively employing external PR firms and industrial clubs to integrate with their regional innovation systems (Table 111).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: Age, collaborative vs. proprietary				
Collaborative vs. proprietary	0,369	0,005	57	Significant at the 0.01 level (2-sided)
Age (founding date)	-0,442	0,000	59	Significant at the 0.01 level (2-sided)
Entry: Location choice (supporting factor)				
Gov. financial incentives	0,319	0,016	57	Significant at the 0.05 level (2-sided)
Integration: Networks important to the integration process				
PR firm networks	0,341	0,008	59	Significant at the 0.01 level (2-sided)
Industrial club networks	0,323	0,012	59	Significant at the 0.05 level (2-sided)

Table 111: Variables significantly correlating with network 'headhunter networks'

They furthermore sought out government financial incentives in their location decisions. The negative correlation indicates that these facilities were founded earlier than those facilities using less headhunter services. From the perspective of the MMB model, this data indicates independent firm-based integration behavior.

5.5.3.10 External PR firm networks

Facilities actively collaborating with external PR firms to facilitate their regional integration also used internal PR departments, external advertising agencies, industrial clubs, internal HR departments, host country non-R&D manager personal networks, and headhunter networks more actively than facilities not seeking the services of external PR firms (Table 112).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Entry: Location choice (supporting factor)				
Local labor market	0,339	0,028	42	Significant at the 0.05 level (2-sided)
Integration: Networks important to the integration process				
Headhunter network	0,341	0,008	59	Significant at the 0.01 level (2-sided)
Internal PR department network	0,506	0,000	59	Significant at the 0.01 level (2-sided)
Ad agency network	0,458	0,000	59	Significant at the 0.01 level (2-sided)
Industrial club network	0,438	0,001	59	Significant at the 0.01 level (2-sided)
Internal HR department network	0,375	0,003	59	Significant at the 0.01 level (2-sided)
Host country non-R&D mgr. personal network	0,351	0,006	59	Significant at the 0.01 level (2-sided)

Table 112: Variables significantly correlating with network 'external PR firm networks'

Their location decisions were also more driven by a favorable local labor market. The networks favored by these facilities are thus the external third party networks, that in the sense of the MMB model, indicate independent firm-based integration behavior.

5.5.3.11 EXTERNAL ADVERTISING AGENCY NETWORKS

Facilities more actively working with external advertising agencies were also more active with external PR firms, internal PR departments, and internal HR departments to integrate with the regional innovation systems (Table 113).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Entry: Location decision (supporting factor)				
Public transport infrastructure	0,323	0,012	59	Significant at the 0.05 level (2-sided)
Integration: Networks important to the integration process				
PR firm networks	0,458	0,000	59	Significant at the 0.01 level (2-sided)
Internal PR department networks	0,354	0,006	59	Significant at the 0.01 level (2-sided)
Internal HR department networks	0,334	0,010	59	Significant at the 0.01 level (2-sided)

Table 113: Variables significantly correlating with network 'external advertising agency networks'

Their location decisions were more influenced by the local presence of a superior public transport infrastructure. The data does not hold special implications for the MMB model.

5.5.3.12 Industrial Club Networks

Facilities seeking industrial club networks to integrate with their RIS were also more active in open industrial networks, while more often using external PR firms, internal PR departments, non-industrial club networks, government matchmaking networks, external headhunters, and internal HR departments to integrate with the regional innovation system (Table 114).

Independent variables (Industrial club networks)	Pearson Correlation	Significance (2-sided)	N	Significance Level
Entry: Location decisions (supporting factors)				
Complementary techn. companies	0,463	0,000	59	Significant at the 0.01 level (2-sided)
Public transport infrastructure	0,428	0,001	59	Significant at the 0.01 level (2-sided)
Integration: Collaboration important to the integrations process				
Key customer companies	0,370	0,004	58	Significant at the 0.01 level (2-sided)
Integration: Networks important to the integration process				
Open industrial networks	0,596	0,000	59	Significant at the 0.01 level (2-sided)
PR firm networks	0,438	0,001	59	Significant at the 0.01 level (2-sided)
Internal PR department networks	0,345	0,007	59	Significant at the 0.01 level (2-sided)
Non-industrial club networks	0,333	0,010	59	Significant at the 0.01 level (2-sided)
Gov. matchmaking networks	0,327	0,011	59	Significant at the 0.05 level (2-sided)
Headhunter networks	0,323	0,012	59	Significant at the 0.05 level (2-sided)
Internal HR department networks	0,314	0,016	59	Significant at the 0.05 level (2-sided)

Table 114: Variables significantly correlating with network 'industrial club networks'

Their location choice was more often influenced by the presence of key complementary technology companies and a superior transportation infrastructure than that of facilities not as active in industrial club networks. They collaborated more actively with key customer companies than facilities not using industrial club networks. Since PR, advertising, HR, and headhunter networks overall were not used very intensely, the data primarily indicates that industrial club networks are used by facilities with an interest in complementary technology companies and key customer companies.

5.5.3.13 Non-Industrial Club Networks

Facilities actively using non-industrial club networks (defined as networks without a specific industry focus or academic networks) were influenced in their location decisions by a local presence of strong university research and single university institutes, a strong public transport infrastructure and strong local state research (Table 115).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Characteristics: R&D mission				
R&D mission	-0,339	0,009	59	Significant at the 0.01 level (2-sided)
Entry: Location decision (key drivers and supporting factors)				
Strong university research	0,427	0,001	59	Significant at the 0.01 level (2-sided)
Public transport infrastructure	0,354	0,006	59	Significant at the 0.01 level (2-sided)
Univ. institute (key driver)	0,328	0,021	49	Significant at the 0.05 level (2-sided)
Strong state research	0,300	0,022	58	Significant at the 0.05 level (2-sided)
Integration: Networks important to the integration process				
Gov. matchmaking networks	0,354	0,006	59	Significant at the 0.01 level (2-sided)
Industrial club networks	0,333	0,010	59	Significant at the 0.01 level (2-sided)

Table 115: Variables significantly correlating with network 'non-industrial club networks'

In terms of networking behavior, they were active also within government matchmaking networks and industrial club networks. Their R&D missions were more research- than development-driven. In the sense of the MMB model, they were thus research- and S&T-driven.

5.5.3.14 OPEN INDUSTRIAL NETWORKS

Facilities active in open industrial networks (defined as industry-specific networks not requiring membership) were more active in industrial club networks, and more actively used employee personal networks than facilities not as active in open industrial networks, while they also more actively used government matchmaking services as well as internal HR departments (Table 116).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Entry: Location choice (key drivers and supporting factors)				
Large local labor pool	0,358	0,005	59	Significant at the 0.01 level (2-sided)
Single scientist (key driver)	-0,317	0,026	49	Significant at the 0.05 level (2-sided)
Integration: Networks important to the integration process				
Industrial club networks	0,596	0,000	59	Significant at the 0.01 level (2-sided)
Employee personal networks	0,361	0,005	59	Significant at the 0.01 level (2-sided)
Gov. matchmaking networks	0,328	0,011	59	Significant at the 0.05 level (2-sided)
Internal HR department networks	0,300	0,021	59	Significant at the 0.05 level (2-sided)

Table 116: Variables significantly correlating with network 'open industrial networks'

Their location choices were influenced by the presence of a large local labor pool and they were less likely to come to a region due to a single key scientist than facilities not as active in open industrial networks. In the sense of the MMB model, these facilities seem not to be S&T-driven.

5.5.3.15 OPEN NON-INDUSTRIAL NETWORKS

Facilities active in open non-industrial networks (defined as academic and other non-industry-specific networks not requiring membership) were more influenced in their location decisions by the local presence of single university institutes, strong university research, a generally favorable R&D environment, a large local scientific labor pool, and strong state research than facilities not as active in open non-industrial networks (Table 117).

Independent variables	Pearson Correlation	Significance (2-sided)	N	Significance Level
Entry: Location decision (key drivers and supporting factors)				
Single univ. institute (key driver)	0,558	0,000	49	Significant at the 0.01 level (2-sided)
Strong university research	0,403	0,002	59	Significant at the 0.01 level (2-sided)
R&D environment	0,371	0,004	59	Significant at the 0.01 level (2-sided)
Public transport infrastructure	0,326	0,012	59	Significant at the 0.05 level (2-sided)
Large local labor pool	0,319	0,014	59	Significant at the 0.05 level (2-sided)
Strong state research	0,313	0,017	58	Significant at the 0.05 level (2-sided)
Integration: Collaboration important to the integration process				
Complementary techn. companies	-0,278	0,035	58	Significant at the 0.05 level (2-sided)
Competitor companies	-0,303	0,021	58	Significant at the 0.05 level (2-sided)
Integration: Networks important to the integration process				
Internal HR department networks	0,331	0,010	59	Significant at the 0.05 level (2-sided)

Table 117: Variables significantly correlating with network 'open non-industrial networks'

They were also more active with internal HR departments in order to integrate with the RIS than facilities not active in these networks. However, they collaborated less actively with complementary technology companies and competitor companies that facilities not as active in open non-industrial networks. This data indicates S&T-driven R&D internationalization motives, however not of industrial, but of academic nature. This insight makes sense due to the fact that most non-industrial networks are academic networks.

5.5.4 Conclusion on global entry behavior of R&D facilities

The data on collaboration partners and networks as enablers of the integration process adds to the validity of the MMB as a tool to characterize foreign-owned R&D facilities world-wide. Pearson correlations, as indicated in the tables, show how different types of integration behavior correlate with different categories within the context of the MMB model.

5.6 Summary: global patterns in R&D internationalization

The correlations in the above sections covered the three areas of investigation of this research: (1) characteristics of foreign-owned R&D facilities, (2) their entry behavior, and (3) their integration behavior. The following overview (Table 118) summarizes the most meaningful results and presents them within the context of the MMB model as a framework for describing foreign-owned R&D facilities world-wide. These indications are made based on the above correlation calculations as well as the insight gained earlier in this research.

	Mission		Motive				Behavior	
Characteristics	**Research**	**Development**	**Market-**	**S&T-**	**Customer-**	**Cost-**	**Independent**	**Network**
R&D mission	R	D	D, R	R, D	D	D, R	D	R, D
Age	-	-	-	-	-	-	Old	young
Growth	-	-	-	-	-	-	Slow	fast
Mgr. nationality	host	Home	-	-	-	-	Home	host
Size partner netw.	-	-	-	-	-	-	Small	Large
Explorat. vs. exploit.	explorative	exploitative	exploitative	explorative	explorative	Exploitative	exploitative	explorative
Collabor. vs. propriet.	-	-	-	-	-	-	proprietary	Collaborative
Tacit vs. explicit	-	-	explicit	-	-	-	-	-

	Mission		Motive				Behavior	
Location (key driver)	**Research**	**Development**	**Market-**	**S&T-**	**Customer-**	**Cost-**	**Independent**	**Network**
Single scientist	X			X				X
Univ. institute	X			X				X
Company acquisition	-	-	X					X
Company collaborat'n	-	-			X			X
Technology region	X		X					X
Market potential		X	X		X	X	X	
Labor market		X				X	-	-

	Mission		Motive				Behavior	
Collaboration	**Research**	**Development**	**Market-**	**S&T-**	**Customer-**	**Cost-**	**Independent**	**Network**
Universities	X	X	X	X			-	-
State R&D labs	X			X			-	-
Key customer co's		X			X		-	-
Supplier/vendor co's		X		X			-	-
Compl. techn. co's		X		X			-	-

	Mission		Motive				Behavior	
Networks	**Research**	**Development**	**Market-**	**S&T-**	**Customer-**	**Cost-**	**Independent**	**Network**
Manager personal	X	X		X				X
Employee personal	X			X				X
Government matchm.	X			X			-	-
Industrial networks	-	-	X					X
Non-industrial netw.	X			X				X

Table 118: Summary overview of global patterns in R&D internationalization

Due to the global character of the sample, numerous regional specificities are lost when taking on the global perspective. The heterogeneity of world-wide RIS as well as the fairly small population of foreign-owned R&D facilities in the five regions of study limits the validity of the results. In conclusion, the MMB model presents a framework that can be applied when discussing R&D internationalization as a global phenomenon, but it can also be used to discuss foreign-owned R&D facilities in an intra-regional context. The MMB framework together with the regional typologies present useful tools as a starting point for future research on the internationalization of R&D.

The following section will use two-step cluster analyses to include the qualitative variable ‘location’ into the global analysis while checking for overlaps between the identified regional and global typologies. It indicates the great heterogeneity of foreign-owned R&D facilities world-wide, while at the same time delivering wide-ranging support for the models and typologies generated in the earlier sections of the work. A general conclusion summarizes the findings of the research and gives perspectives for future research.

Section 6: two-step cluster analyses

6.1 Introduction

To verify regional patterns of location, entry, and integration of foreign-owned R&D, two-step cluster analyses are conducted in this section using the 'location' variable as a basis for the construction of clusters with the greatest possible homogeneity. Efforts to also identify industry-specific trends in the internationalization of R&D by constructing clusters based on the 'industry' variable showed no significant results and were thus completely omitted from this paper. The conclusion is that there are no identifiable patterns of internationalization of R&D based on the 'industry' variable. The section goes on to describe the results of each of the two-step cluster analyses conducted, while the corresponding figures containing graphic evaluations can be found in the Statistical Appendix at the end of this paper.

6.2 Statistical method: two-step cluster analysis

The two-step cluster analysis procedure is an exploratory tool designed to reveal natural groupings (or clusters) within a data set that would otherwise not be apparent. The algorithm employed enables the handling of categorical and continuous variables, and the automatic selection of number of clusters (by comparing the values of a model-choice criterion across different clustering solutions, the procedure automatically determines the optimal number of clusters). The procedure produces information criteria by number of clusters in the solution, cluster frequencies for the final clustering, and descriptive statistics by cluster for the final clustering. The method assumes that variables in the cluster model are independent. Further, each continuous variable is assumed to have a normal (Gaussian) distribution, and each categorical variable is assumed to have a multinomial distribution. Empirical internal testing indicates that the procedure is fairly robust to violations of both the assumption of independence and the distributional assumptions. The two-step cluster analyses were calculated using the software SPSS. The program generates tables and histograms (see Statistical Appendix) showing clusters each generated by the program to display maximum possible internal homogeneity with respect to two selected variables.

6.3 Cluster analyses – R&D characteristics

6.3.1 Location/mission clusters

The first analysis was devoted to the generation of clusters around the variables R&D location and R&D mission. Based on the insight up to this point in the research, a heterogeneous picture is expected, development being present if not dominant in each of the regions. The clusters should therefore vary as a function of the number of research conducting facilities they contain.

In fact, the analysis delivers two clusters. Cluster 1 is referred to as the 'dual R&D or development-driven cluster', while Cluster 2 is referred to as the 'research- or development-driven cluster'. London turns out to be the most heterogeneous of the five locations, spread equally between Clusters 1 and 2 with research-, development-, and dual R&D-driven facilities. Beijing and Stockholm, located in Cluster 1, are determined by dual R&D strategies and a much stronger development- than research focus. Munich and Cambridge, located within Cluster 2, are in sum more research- than development-driven. This insight is in line with previous findings and adds validity to the original regional typologies that were based on the intra-regional perspective.

6.3.2 Location/age clusters

This analysis was devoted to the generation of clusters around the variables R&D location and facility age. Based on the insight up to this point in the research, there should be clear clusters showing the different ages of foreign-owned R&D facilities at the different locations.

The analysis delivers three clusters. Cluster 1 is referred to as the 'young cluster', Cluster 2 is referred to as the 'middle-aged cluster', Cluster 3 is referred to as the 'old cluster'. Beijing hosts the youngest facilities, whereas both London and Cambridge host both young as well as old facilities (none of the facilities of London or Cambridge were in Cluster 2). Munich, with 50 percent in Cluster 1, 25 percent on Cluster 2, and 25 percent in Cluster 3 is the most heterogeneous of the five locations. Stockholm, with 86 percent in the young cluster and the middle-aged cluster is the second youngest foreign R&D location in the global sample. This data supports the regional typologies presented above.

6.3.3 Location/size clusters

This analysis was devoted to the generation of clusters around the variables R&D location and facility size. Based on the insight up to this point in the research, there should be a cluster with the larger facilities in the large cities covered in this research (Beijing, London, Munich) and a cluster with the smaller facilities in the smaller cities covered (Stockholm, Cambridge).

The picture however, is not as clear. The analysis delivers three clusters but these clusters are not homogenous in terms of the facility sizes they contain. The analysis shows that facility ages are more heterogeneous than previously expected. Especially Cambridge, Beijing, London, and Stockholm are heterogeneous in terms of the sizes of their foreign owned R&D facilities, while Munich, is slightly more clustered around medium sized R&D facilities, but is also fairly heterogeneous across all facility size groups.

There are thus no clearly identifiable regional models of facility size in the sample, even if the intra-regional analyses conducted above raised the issue that there might be. However, the two-step cluster analysis in this case does not provide any data that would support or contradict the five generic regional typologies.

6.3.4 Location/growth clusters

This analysis was devoted to the generation of clusters around the variables R&D location and facility growth rates. Based on the insight up to this point in the research, there should be a clearly identifiable faster growth cluster (with fast and medium growth facilities), as well as a slower growth cluster (with slow, zero, or negative growth clusters).

Indeed, the analysis delivers two clusters. Cluster 1 is referred to as the 'medium to fast growth cluster' while Cluster 2 is referred to as the 'slow or negative growth cluster'. Beijing and Munich are the most prominent members of the medium to fast growth cluster. London, Cambridge, and Stockholm on the other hand find themselves mainly in the negative or slow growth cluster, even if negative growth was the clear minority here. This data on growth is somewhat in contradiction of the intra-regional analyses, since Stockholm growth rates were found to be faster than Munich growth rates. However, this data is misleading. Care must be taken in the analysis due to the heterogeneity of the clusters. Cambridge, Munich, and London had more facilities in the slow growth cluster than Stockholm.

Nonetheless, the analysis supports the main findings of the intra-regional analyses and generates support for the regional typologies as well as the MMB model for the description of facilities within regional contexts.

6.3.5 Location/size of key partner network clusters

This analysis was devoted to the generation of clusters around the variables R&D location and the size of facility key partner networks. Based on the insight up to this point in the research, there should be a cluster with facilities collaborating in larger networks and a cluster with facilities collaborating in smaller networks.

The analysis delivers two clusters. Cluster 1 is referred to as the 'medium to large key partner network cluster', Cluster 2 is thus referred to as the 'small key partner network cluster'. While Beijing, London, Munich are spread almost equally between the two clusters, the data shows that Cambridge is the location with the smallest overall key collaboration partner networks. Stockholm, fully in Cluster 1, does not display any of the small key partner network sizes. Due to the large heterogeneity of the other three locations in terms of the sizes of their key partner networks, no patterns can be identified here. This data confirms the original typologies, since Cambridge, the 'small is beautiful' RIS would not be expected to host facilities with large partner networks, and since Stockholm, which hosts both facilities with S&T- and customer company-driven motives would be expected to imply slightly larger networks than the Cambridge RIS.

6.3.6 Location/manager nationality clusters

This analysis was devoted to the generation of clusters around the variables R&D location and facility manager nationality. Based on the insight up to this point in the research, there should be a cluster around the dual nationality types found in Beijing, as well as a cluster containing mainly host country national managers found in the UK locations, Sweden, and Germany.

The analysis in fact delivers three clusters. Cluster 1 is referred to as the ‘home country and dual nationality cluster’, Cluster 2 is referred to as the ‘home and host country nationality cluster’, and Cluster 3 is referred to as the ‘host country nationality cluster’. Beijing, in Cluster 1, is dominated by home and dual nationality types, whereas London, in Cluster 2, is dominated by home and host country nationals. Cambridge, Munich, and Stockholm, all concentrated within Cluster 3, display for the most part host country nationality managers. The data thus indicates that the dual nationality model is a unique Beijing model, that London is heterogeneous in terms of manager nationalities, and that the other three locations, almost exclusively chose host country management and thus give priority to local integration over parent company integration. This data confirms the original intra-regional analyses.

6.3.7 Location/explorative vs. exploitative clusters

This analysis was devoted to the generation of clusters around the variables R&D location and the character of knowledge work dimension ‘explorative vs. exploitative’. Based on the insight up to this point in the research, the explorative/exploitative dimension correlates with the R&D mission of the facilities. Therefore similar cluster results as seen above in the location/R&D mission two-step cluster analysis are expected.

However, the analysis delivers four clusters. Cluster 1 is therefore referred to as the ‘exploitative cluster’, Cluster 2 is referred to as the ‘mainly exploitative cluster’, Cluster 3 is referred to as the ‘explorative cluster’, while Cluster 4 is referred to as the ‘explorative/explorative cluster’. The data implies that Beijing is a highly exploitative location, while Munich hosts exploitative, explorative, and explorative/exploitative R&D combinations. Cambridge is rather polarized, with highly explorative and highly exploitative facilities, while London is the most heterogeneously positioned, covering both extremes, as well as the midrange. Stockholm is much more exploitative than explorative. Again, this supports the regional typologies and the results of the intra-regional analyses.

6.3.8 Location/collaborative vs. proprietary clusters

This analysis was devoted to the generation of clusters around the variables R&D location and the character of knowledge work dimension 'collaborative vs. proprietary'. Based on the insight up to this point in the research, London and Cambridge should form a cluster with the more proprietary-minded facilities, while the rest of the locations should form a cluster with the less proprietary-minded facilities.

In line with expectations, the analysis delivers three clusters. Cluster 1 is referred to as the 'collaborative cluster', Cluster 2 is referred to as the 'proprietary cluster' and Cluster 3 is referred to as the 'collaborative and proprietary cluster'. Regardless of the heterogeneity in the data, it shows that Beijing is equally divided between facilities claiming collaborative and/or proprietary work, while Cambridge displays a tendency towards proprietary work. London tends towards proprietary work, and Munich is divided equally between all three categories, as is Stockholm. This confirms the original analysis, indicating that Munich and Stockholm are more collaborative than Cambridge and London, which were more proprietary in their nature.

6.4 Cluster analyses – R&D entry characteristics

6.4.1 Key location decision drivers

6.4.1.1 LOCATION/SINGLE SCIENTIST TO COLLABORATE WITH CLUSTERS

This analysis was devoted to the generation of clusters around the variables R&D location and the aim to collaborate locally with a single scientist as a key driver to the location decision. Based on the insight up to this point in the research, this should be the case in technology-driven regions such as Cambridge and less so in market-driven regions such as Munich.

The analysis delivers four clusters. Clusters 1, 3, and 4 are referred to as 'low relevance of single scientists clusters'. Cluster 2 is referred to as the 'medium and high relevance of single scientists cluster'. The data implies that Cambridge is a medium to high relevance of single scientists location, Beijing, London, and Munich are low relevance of single scientist locations, while Stockholm has elements of both location types. This data is in line with the Cambridge regional typology, which indicates that foreign-owned facilities are frequently built up around single scientists who are leaders in their field.

6.4.1.2 LOCATION/UNIVERSITY INSTITUTE TO COLLABORATE WITH CLUSTERS

This analysis was devoted to the generation of clusters around the variables R&D location and the aim to collaborate locally with a specific university institute as a key driver to the location decision. Based on the insight up to this point in the research, this should be the case Cambridge mainly for purposes of S&T, and in Beijing, London, and Munich mainly for purposes of recruitment. In Stockholm, universities played the least important role according to the intra-regional analysis.

The analysis delivers three clusters. Cluster 1 is referred to as the ‘high relevance of single university institutes cluster’, while Clusters 2 and 3 are referred to as ‘low relevance of single university institutes clusters’. The data implies that Cambridge is a high relevance of single university institutes location. Beijing hosts facilities attributing low, medium, and high relevance to single university institutes. London, Munich, and Stockholm each are low relevance of single university institutes locations. This data corresponds to the regional typologies attributed to the locations above, Cambridge being the university-centric RIS.

6.4.1.3 LOCATION/COMPANY TO COLLABORATE WITH CLUSTERS

This analysis was devoted to the generation of clusters around the variables R&D location and the aim to collaborate locally with a specific company as a key driver of the location decision. Based on the insight up to this point in the research, the heterogeneity within each of the five locations should make it difficult to generate distinct clusters in this case. The two-step cluster analysis is nonetheless conducted as a means to verify the original assumption.

As expected, the analysis delivers three highly heterogeneous clusters. Cluster 1 is referred to as the ‘low relevance of specific company to collaborate with cluster’, Cluster 2 is referred to the ‘low/medium/high relevance of specific company to collaborate with cluster’, and Cluster 3 is referred to as the ‘medium to high relevance to of specific company to collaborate with cluster’. The data indicates that Beijing and Stockholm make up the ‘low relevance’ Cluster, Beijing, Munich, and Stockholm together constitute the ‘medium to high relevance’ cluster, while Cambridge, London, and Munich together constitute the ‘low/medium/high relevance’ cluster. This heterogeneity does not allow for any regional typologies relating to specific companies to collaborate with serving as key location decision drivers.

6.4.1.4 Location/company to acquire clusters

This analysis was devoted to the generation of clusters around the variables R&D location and the aim to acquire a specific company as a key driver to the location decision. Based on the insight up to this point in the research, there should be a cluster with a high relevance of acquisitions in the London, Cambridge, and Stockholm, whereas there should be a cluster with a low relevance of acquisitions in Munich and Beijing.

The picture however, is a little bit more complex. The analysis delivers four clusters. Clusters 1, 3, and 4 are referred to as the ‘low relevance of specific companies to acquire clusters’, while Cluster 2 is referred to as the ‘high relevance of specific companies to acquire cluster’. The data implies that approximately 50 percent of each of the London and Stockholm facilities plus small amounts of the Cambridge, Munich, and Beijing facilities constitute the high relevance cluster, while the largest part of the Beijing, Munich, and Cambridge facilities constitute the low relevance clusters. London and Stockholm thus are the most attractive RIS for foreign R&D acquisitions, which corresponds well with the insight given by the regional typologies.

6.4.1.5 Location/foreign technology region clusters

This analysis was devoted to the generation of clusters around the variables R&D location and the importance of the foreign technology region as a key driver to the location decision. Based on the insight up to this point in the research, there should be a cluster especially containing the technology-driven facilities in Cambridge, and another cluster containing the more market-driven facilities.

The analysis delivers four clusters. Cluster 1 is referred to as the ‘low relevance of technology region cluster’, Cluster 2 is referred to as the ‘medium relevance of technology region cluster’, Cluster 3 is referred to as the ‘low or high relevance of technology region cluster’, while Cluster 4 is referred to as the ‘high relevance of technology region cluster’. The data indicates that Beijing hosts facilities belonging to the low and medium relevance clusters, Cambridge facilities belong to the high relevance cluster, Munich and London host facilities from the low and high relevance clusters 1, 3, and 4, while Stockholm hosts facilities from the medium and low or high relevance clusters. Again, this data supports the regional typologies, taking into account that Beijing facilities follow mainly market- and cost-driven motives, Cambridge facilities follow S&T-driven motives, Munich and London to a large part follow market-driven motives, and Stockholm facilities follow S&T- and key customer company-driven motives.

6.4.1.6 LOCATION/FOREIGN MARKET POTENTIAL CLUSTERS

This analysis was devoted to the generation of clusters around the variables R&D location and the importance of the foreign market potential as a key driver to the location decision. Based on the insight up to this point in the research, there should be a cluster with high levels of importance for those locations that are market-driven, and a cluster with low levels of importance for those locations that are technology-driven.

The analysis delivers two clusters. Cluster 1 is referred to as the ‘high relevance of foreign market potential cluster’ while Cluster 2 is referred to as the ‘low to medium relevance of foreign market potential cluster’. The data indicates that Beijing, London, and Munich are dominated by facilities in the high relevance cluster, while Cambridge and Stockholm are dominated by facilities in the low to medium relevance cluster. This is in correspondence with the regional typologies and the intra-regional analysis.

6.4.1.7 LOCATION/ATTRACTIVE LOCAL LABOR MARKET CLUSTERS

This analysis was devoted to the generation of clusters around the variables R&D location and the attractiveness of the local labor market as a key driver to the location decision. Based on the insight up to this point in the research, there should be a cluster containing highly attractive labor market locations and another location for less attractive labor market locations.

The picture however, is quite heterogeneous. The analysis delivers four clusters. Cluster 1 is referred to as the ‘high relevance of local labor market cluster’, Cluster 2 is referred to as the ‘low and high relevance of local labor market cluster’, Cluster 3 is referred to as the ‘medium or high relevance of local labor market cluster', and Cluster 4 is referred to as the 'low relevance of local labor market cluster'. The data shows that Beijing facilities are mainly in the high relevance cluster, Cambridge facilities are mainly in the medium to high relevance cluster, London and Stockholm host facilities from the low or high relevance cluster, while Munich holds facilities both from the low and the medium or high relevance clusters. Cost- and S&T-driven motives are reflected in the Beijing and Cambridge cases, whereas heterogeneity determines the other locations.

6.5 Cluster analyses – R&D integration characteristics

6.5.1 Collaboration partners

6.5.1.1 LOCATION/UNIVERSITIES CLUSTERS

This analysis was devoted to the generation of clusters around the variables R&D location and the importance of universities as collaboration partners. Based on the insight up to this point in the research, there should be a cluster of facilities in regions strongly collaborating with universities and another cluster of facilities in regions collaborating less strongly with universities.

The results were complex, the analysis delivers six clusters. Cluster 1 is referred to as a 'medium relevance cluster', Cluster 2 is referred to as a 'low relevance cluster', Cluster 3 is referred to as a 'low, medium, and high relevance cluster', while Clusters 4, 5, and 6 are referred to as 'high relevance clusters'. The data shows that all locations host facilities attributing high, medium, and low importance to university collaborations. No regional typologies of collaboration preference can be attributed based on this analysis, even though universities clearly do play different roles of differing importance in each of the locations as discussed above.

6.5.1.2 LOCATION/STATE RESEARCH LABS CLUSTERS

This analysis was devoted to the generation of clusters around the variables R&D location and the importance of state research labs as collaboration partners. Based on the insight up to this point in the research, there should be a cluster of importance surrounding Munich and Beijing, while the other locations would not be expected to host much state research collaborations.

The analysis delivers two clusters. Cluster 1 is referred to as the 'high relevance cluster' and Cluster 2 is referred to as the 'low and medium relevance cluster'. The data shows that Beijing and London host roughly an equal amount of facilities in each cluster, while most Cambridge facilities belong to the low and medium relevance cluster. Stockholm belongs fully to the low to medium relevance cluster. Munich hosts both facilities from the high relevance and the low and medium relevance clusters.

6.5.1.3 LOCATION/LEAD CUSTOMER COMPANIES CLUSTERS

This analysis was devoted to the generation of clusters around the variables R&D location and the importance of lead customer companies as collaboration partners. Based on the insight up to this point in the research, there should be a cluster of high importance where market-driven facilities collaborate more so with companies than with universities or state research institutes. However the results of the two-step cluster analysis were highly heterogeneous, not allowing for any regional typologies regarding lead customer collaborations.

6.5.1.4 LOCATION/SUPPLIER/VENDOR COMPANIES CLUSTERS

This analysis was devoted to the generation of clusters around the variables R&D location and the importance of supplier/vendor companies as collaboration partners. Based on the insight up to this point in the research, it should be difficult to generate clear regional clusters based on these variables due to the heterogeneity identified in each of the regions in this dimension.

Nonetheless, the analysis delivers three clusters. Cluster 1 is referred to as the 'low relevance of supplier/vendor company collaborations cluster', and Clusters 2 and 3 are referred to as the 'medium to high relevance clusters'. The data shows that Beijing and London belong to the low and medium to high relevance clusters, Cambridge belongs mainly to the low relevance cluster, Munich lies in a medium to high relevance cluster, as does Stockholm. This data is in line with the regional typologies and the intra-regional analyses due to the heterogeneity of the London RIS, the academic S&T-driven motives in the Cambridge RIS, the market-driven characteristics of the Munich and Beijing RIS, and the partial industrial S&T-driven motives in the Stockholm RIS.

6.5.1.5 LOCATION/COMPLEMENTARY TECHNOLOGY COMPANIES

This analysis was devoted to the generation of clusters around the variables R&D location and the importance of complementary technology companies as collaboration partners. Based on the insight up to this point in the research, it should be difficult to generate clear regional clusters based on these variables due to the heterogeneity identified in each of the regions in this dimension. Accordingly, the analysis delivers two highly heterogeneous clusters. Regional typologies of the importance of complementary technology companies are thus not possible to make based on this data.

6.5.1.6 LOCATION/COMPETITOR COMPANIES CLUSTERS

This analysis was devoted to the generation of clusters around the variables R&D location and the importance of competitor companies as collaboration partners. Based on the insight up to this point in the research, the relevance of competitor company collaborations was very low in each of the covered regions. Thus meaningful results from the two-step cluster analysis are not to be expected.

Even though the analysis delivers three clusters, the data is not meaningful for the appraisal of the regional typologies. Cluster 1 is referred to as the ‘low relevance of competitor collaborations cluster’, Cluster 2 is referred to as the ‘low or high relevance of competitor collaborations cluster’, and Cluster 3 is referred to as the medium relevance cluster. The data shows that Beijing, Cambridge, and Stockholm facilities principally attribute low importance to competitor collaborations while each of them host facilities attributing medium importance as well. London and Munich host both facilities attributing low and high importance to these collaborations, as well as medium importance.

6.5.2 Networks

6.5.2.1 LOCATION/R&D MANAGER PERSONAL NETWORKS CLUSTERS

This analysis was devoted to the generation of clusters around the variables R&D location and the importance of R&D manager personal networks for regional integration. Based on the insight up to this point in the research, the importance of manager personal networks was high in each of the regions, so that is doubtful whether meaningful clusters can be generated.

The analysis nonetheless delivers four clusters. Clusters 1, 3, and 4 are referred to as 'high relevance of management networks clusters', while Cluster 2 is referred to as the 'low to medium relevance of management networks cluster'. The data shows that each of the locations is part of 'high relevance' clusters, while between 11 and 25 percent of each location's facilities come from the low to medium relevance cluster. The same result was reached in the intra-regional analysis.

6.5.2.2 LOCATION/R&D EMPLOYEE PERSONAL NETWORKS CLUSTERS

This analysis was devoted to the generation of clusters around the variables R&D location and the importance of employee personal networks for regional integration. Based on the insight up to this point in the research, employee personal networks were similarly important in each of the regions, so that significant clusters are not expected. The result here is indeed very similar to that of the analysis of the manager personal networks conducted above. Each of the locations showed high and medium relevance of employee personal networks.

6.5.2.3 LOCATION/HOME COUNTRY MANAGER PERSONAL NETWORKS CLUSTERS

This analysis was devoted to the generation of clusters around the variables R&D location and the importance of home country manager personal networks for regional integration. Based on the insight up to this point in the research, home country managers are expected to play a more important role where integration is conducted 'top down' rather than 'bottom up'.

The analysis delivers two clusters. Cluster 1 shows high and medium importance, while Cluster 2 shows low importance. The data shows that home country manager networks played a more important role in Beijing and Cambridge than they did in the other RIS. The top-down approach to regional integration was described above and corresponds well to the Beijing RIS. The data in the case of Cambridge must be interpreted in a way that home country manager personal networks are merely important very early on as foreign-owned facilities are being set up here. Later on, regional integration is left very much up to the local R&D manager.

6.5.2.4 LOCATION/CONSULTANT NETWORKS CLUSTERS

This analysis was devoted to the generation of clusters around the variables R&D location and the importance of consultant networks for regional integration. Based on the insight up to this point in the research, consultant networks did not play much of a role in any of the locations, so that it is questionable, whether meaningful clusters can be created.

The analysis delivers two clusters. Low importance was recorded in Clusters 1 and 2, while high relevance was recorded in Cluster 2. Medium importance was recorded in Cluster 1. Clear labels leading to typologies can thus not be given due to heterogeneity. However, the data shows that Beijing and London have the least of presence in Cluster 2, indicating that facilities in these locations use consultant networks less than the facilities in the other regions.

6.5.2.5 LOCATION/GOVERNMENT MATCHMAKING NETWORKS CLUSTERS

This analysis was devoted to the generation of clusters around the variables R&D location and the importance of government matchmaking networks for regional integration. Based on the insight up to this point in the research, government matchmaking is expected to play more of a role where the government and government institutions play more of a role in the regional innovation systems, in this case, in China and Germany.

The analysis delivers three clusters. In terms of the importance of government matchmaking networks in the integration process, high and medium levels of importance were recorded in Cluster 1, while low importance was recorded in Clusters 2 and 3. The data thus shows that government matchmaking played the least important role in Cambridge, followed by Stockholm. Government matchmaking played more important roles in London, Munich, and especially in Beijing. This indicates that government matchmaking played a role in larger RIS, rather than in smaller RIS, and indeed, as expected in regions where government is involved in RIS (with the exception of London).

6.5.2.6 LOCATION/INDUSTRIAL CLUB NETWORKS CLUSTERS

This analysis was devoted to the generation of clusters around the variables R&D location and the importance of industrial club networks for regional integration. Based on the insight up to this point in the research, industrial club networks would be important in mature technology regions with well organized networking infrastructures such as London and Munich.

The analysis delivers two clusters. In terms of the importance of industrial club networks in the integration process, high and medium importance was recorded in Cluster 1, while low relevance was recorded in Cluster 2. The data thus shows that each of the regions except Stockholm have a tendency towards medium to high importance of industrial club networks, while Stockholm had a slight tendency towards a low relevance of these networks in the integration process. This insight would be in line with the tight-knit personal networks important in the Stockholm RIS, possibly making formalized industrial clubs irrelevant in the regional integration process.

6.5.2.7 LOCATION/NON-INDUSTRIAL CLUB NETWORKS CLUSTERS

This analysis was devoted to the generation of clusters around the variables R&D location and the importance of non-industrial club networks for regional integration. Based on the insight up to this point in the research, non-industrial club networks usually imply academic networks, and can thus be expected to be of importance where universities, university institutes, and single scientists had an influence on the location decision.

The analysis delivered three clusters. High and medium levels of importance were recorded in Cluster 2, while low importance was recorded in Clusters 1 and 3. The data confirms that non-industrial clubs typically do not play roles of much importance in the integration process, while in relative terms, they played the most important roles in Cambridge, Munich, and Beijing.

6.6 Summary and conclusion: insight gained through two-step cluster analyses

The two-step cluster analyses conducted in this section provide support for the validity of the regional typologies as well as the results of the intra-regional analyses. The heterogeneity of foreign-owned R&D facilities world-wide in combination with the fairly small size of the global sample (62 cases in five regions) however limit the clarity of the pictures to be gained from the cluster analysis. It was clear from the outset of this research that the different types of innovation systems would have considerable overlaps, which becomes apparent in the heterogeneity of the clusters in this analysis. However, patterns and tendencies clearly emerge nonetheless. Since the five RIS in this research are described as a function of the foreign-owned R&D centers that populate them, the two-step cluster analysis confirms the regional typologies as attracting different kinds of foreign-owned R&D facilities with distinct characteristics, and displaying distinct entry and integration behavior. The MMB model, which was presented and discussed above as a framework for the description of facility characteristics is thus a relevant tool to describe the internationalization of R&D in regional contexts.

General conclusion

The aim of this research was to examine regional specificities of foreign-owned R&D and to develop models that would describe regional and global patterns in the internationalization of R&D. In a theoretical introduction, the concept of compatibility between corporate and regional innovation systems was developed to enable a discussion of the issues surrounding the setting up of R&D facilities abroad. A model showing the elements of a regional innovation system was created to enable the formulation of five generic regional typologies as the foundation for the empirical study that would follow. Within each of these regions, foreign-owned R&D facilities were then examined for their characteristics, their regional entry behavior, and their regional integration behavior. To provide a framework for the discussion of which types of foreign-owned R&D facilities would typically be found in which types of regional innovation systems, the MMB (Mission, Motive, Behavior) model was developed. The intra-regional analysis provided support for the validity of the regional typologies as well as the MMB model as an important tool to describe and compare foreign-owned R&D facilities worldwide. Regardless of great heterogeneity among the regional populations of foreign-owned R&D facilities, the regional typologies on average each host different constellations of MMB characteristics combinations. Following the intra-regional discussions, the facilities were checked for global patterns in the internationalization of R&D. Due to the great heterogeneity of the global sample, global patterns did not emerge as clearly as the regional patterns did in the intra-regional analyses. However, the global analysis, applied to the MMB model, complemented the regional analysis in its own application to the MMB model. Thus, the result of the two analyses can be understood as a regional and a global dimension to the MMB model. Understanding these two dimensions in different regional contexts will assist policy makers and R&D managers in understanding the issues surrounding the internationalization of R&D in their own regional and corporate surroundings. Finally, two-step cluster analyses were conducted in the final section of this research in order to check the validity of the regional analyses in the context of a global analysis, and to identify possible overlaps between the two dimensions. The clusters, as indicated above, are highly heterogeneous, merely indicating trends as opposed to clear pictures. This however, was to be expected. The clusters confirm many of the insights gained from the prior intra-regional and global analyses, thus adding to the validity of the regional typologies and the two-layer (regional, global) structure of the MMB model. In summary, the data and its analyses enabled the fulfillment of the research aim. It furthermore identified many areas for further research and touched upon numerous hypothesis that could not be answered in this research but should be addressed in the future in order to enable a more holistic understanding of the phenomenon of the internationalization of R&D.

Overview of some key indications derived from the data:

- R&D internationalization can be described by the phases location, entry, integration
- It is possible to distinguish innovation environments using the proposed regional typology
- RIS can be urban center-, university-, key company-, government-, or triple-helix-centric
- It is possible to distinguish R&D facilities in regional contexts using the MMB model
- R&D facilities can follow research and/or development missions
- R&D facilities in general are market-, S&T-, key customer-, or cost-motive driven
- R&D facilities can display network-, or independent firm-based integration behavior
- Development is more internationalized than research regardless of location
- Development facilities seek markets, customers, suppliers, and exploitative work
- Research facilities seek universities, state labs, specific scientists, and explorative work
- Development facilities are less analytical in their location decisions than research facilities
- Facilities vary considerably in size and growth rate depending on location
- Partner networks grow proportionally to facility size, independently of location
- Most management is of host country nationality, dual nationalities are common in Beijing
- Entry behavior is strongly determined by facilities' S&T or market-seeking objectives
- Greenfield and acquisition entries are most common regardless of location
- Importance of collaboration partner types varies as a function of the MMB characteristics
- Physical distance to collaboration partners is often irrelevant, depending on joint purpose
- Employee and R&D management personal networks are most important for integration
- Facilities employing local scientists as managers have most extensive regional integration
- Integration can be pursued top-down or bottom-up depending on parent company strategy
- Top-down integration implies use of parent company executives for integration
- Bottom-up integration implies use of R&D employees for integration
- Government-initiated networking is of little importance in most integration processes
- Competitor companies play little to no role in R&D collaborations

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Figures

Tables

Abbreviations

AC	Acquisition
BMBF	Bundesministerium für Bildung und Forschung
co's	Companies
FDI	Foreign direct investment
GF	Greenfield
gov.	Government
HBA	Home base augmenting
HBE	Home base exploiting
h.c.	Host country
HR	Human resources
ICT	Information and communications industries
IP	Intellectual property
IPR	Intellectual property rights
JETRO	Japan Economic Trade Organization
JV	Joint venture
LOF	Liability of foreignness
mgr.	Manager
mgt.	Management
MMB	Mission-motive-behavior
MNC	Multi-national companies
NIS	National innovation system
OECD	Organization for Economic Cooperation and Development
p.a.	Per annum
PR	Public relations
RIS	Regional innovation system
R&D	Research and development
SME	Small and medium sized enterprises
S&T	Science and technology
univ.	University
US	United States
US	University spin-in
vs.	Versus

Statistical Appendix

Two-step cluster analyses graphic evaluations

Location/mission clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	17	100,0%	0	,0%	6	50,0%	0	,0%	7	100,0%
	2	0	,0%	9	100,0%	6	50,0%	16	100,0%	0	,0%
	Combined	17	100,0%	9	100,0%	12	100,0%	16	100,0%	7	100,0%

R&D mission

		D		R		RD	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	20	55,6%	2	11,8%	8	100,0%
	2	16	44,4%	15	88,2%	0	,0%
	Combined	36	100,0%	17	100,0%	8	100,0%

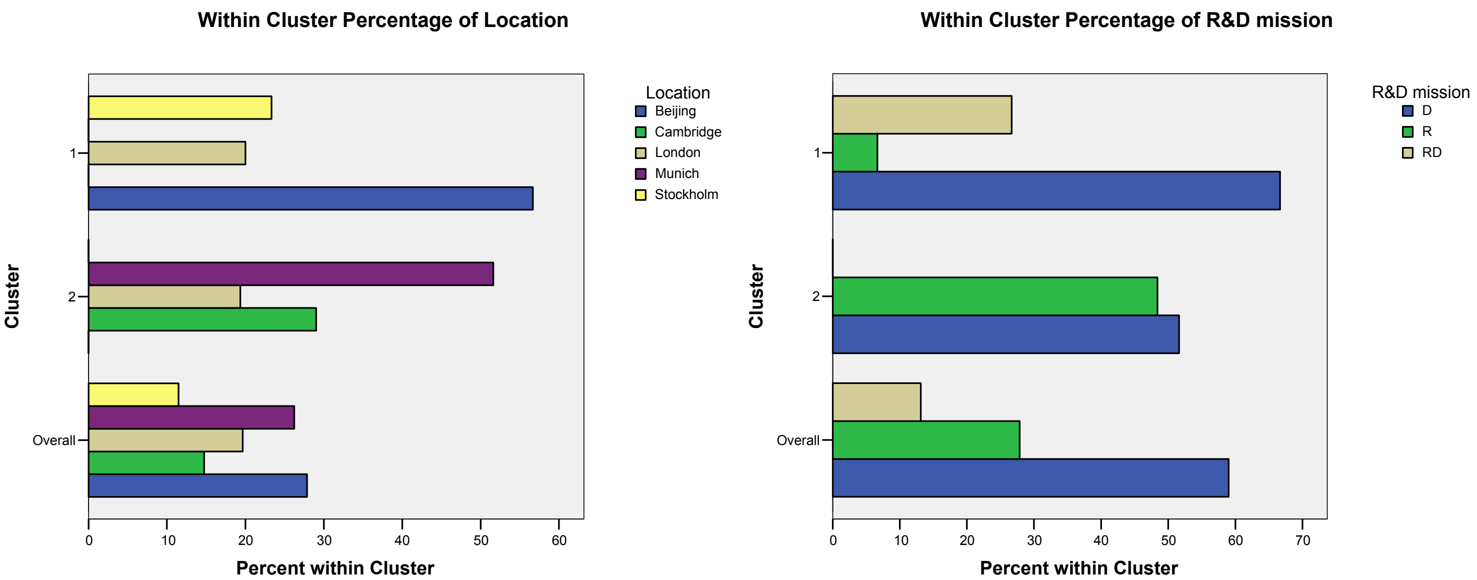


Figure 71: Two-step cluster analysis of location and R&D mission

Cluster 1 contains all of the Beijing facilities, the Stockholm facilities, and 50 percent of the London Facilities. Cluster 2 contains the Munich and Cambridge facilities, as well as the other 50 percent of the London facilities. From the R&D mission perspective, Cluster 1 contains all facilities with dual R&D strategies, 56 percent of pure play development and 12 percent of pure play research facilities. Cluster 2 contains 88 percent of pure play research facilities, and 44 percent of pure play development centers.

Location/age clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	10	58,8%	3	33,3%	2	16,7%	8	50,0%	2	28,6%
	2	6	35,3%	0	,0%	0	,0%	4	25,0%	4	57,1%
	3	1	5,9%	6	66,7%	10	83,3%	4	25,0%	1	14,3%
	Combined	17	100,0%	9	100,0%	12	100,0%	16	100,0%	7	100,0%

Age group

		0-5		11-15		16+		6-10	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	25	100,0%	0	,0%	0	,0%	0	,0%
	2	0	,0%	0	,0%	0	,0%	14	87,5%
	3	0	,0%	10	100,0%	10	100,0%	2	12,5%
	Combined	25	100,0%	10	100,0%	10	100,0%	16	100,0%

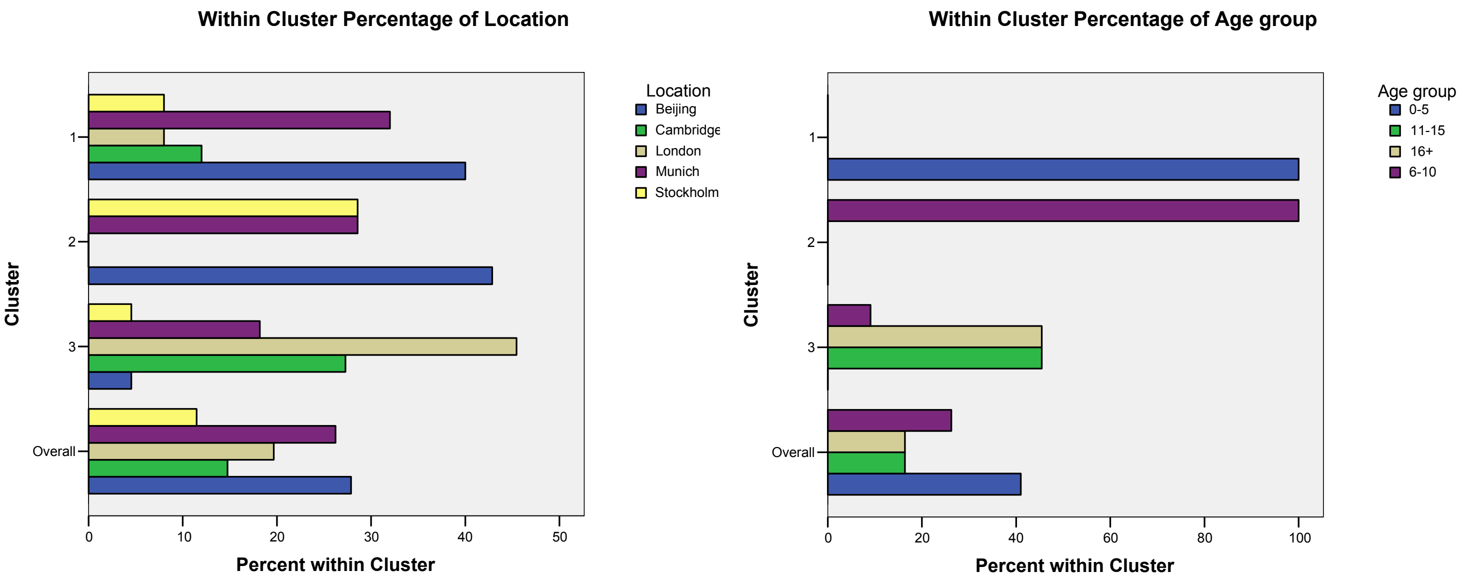


Figure 72: Two-step cluster analysis of location and facility age

Beijing is divided mainly between Clusters 1 and 2, Cambridge between Clusters 1 and 3, London between Clusters 1 and 3, and Munich between all three Clusters. Stockholm is for the largest part divided between Clusters 1 and 2. From the perspective of age, Cluster 1 contains the youngest age group, whereas Cluster 2 contains the second youngest age group. Cluster 3 contains for the most part facilities from the older two age groups.

Location/size clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	16	94,1%	9	100,0%	0	,0%	0	,0%	0	,0%
	2	0	,0%	0	,0%	0	,0%	16	100,0%	0	,0%
	3	1	5,9%	0	,0%	12	100,0%	0	,0%	7	100,0%
	Combined	17	100,0%	9	100,0%	12	100,0%	16	100,0%	7	100,0%

Size today group

		101+		1-10		11-30		31-60		61-100	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	5	35,7%	0	,0%	7	43,8%	7	46,7%	6	85,7%
	2	2	14,3%	3	33,3%	7	43,8%	3	20,0%	1	14,3%
	3	7	50,0%	6	66,7%	2	12,5%	5	33,3%	0	,0%
	Combined	14	100,0%	9	100,0%	16	100,0%	15	100,0%	7	100,0%

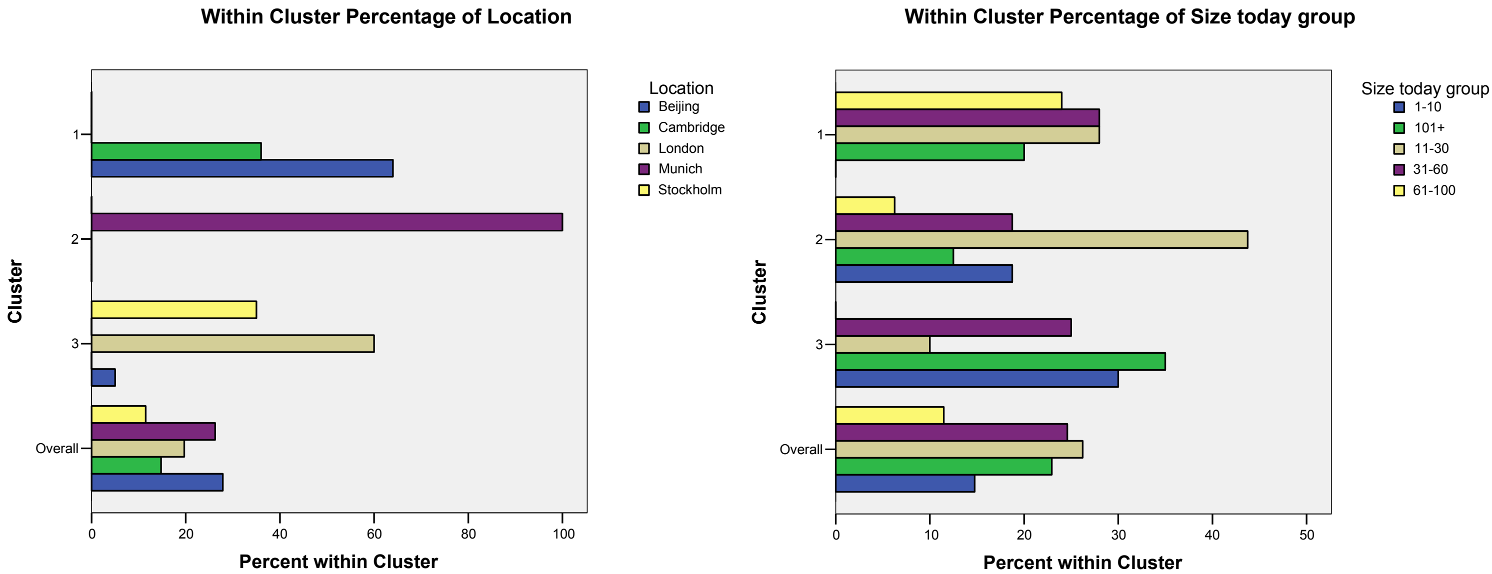


Figure 73: Two-step cluster analysis of location and facility size

Beijing for the largest part lies within Cluster 1, as does the whole of Cambridge. London and Stockholm lie completely in Cluster 3, while Munich lies completely in Cluster 2. From the perspective of size, the smallest facilities lie in Cluster 3 (67 percent) and Cluster 2 (33 percent), the second smallest group lies divided mainly between Cluster 1 (44 percent) and Cluster 2 (44 percent), the next largest group is divided between all three clusters, the next largest lies divided between Clusters 1 (86 percent) and 2 (14 percent), while the group with the largest facility sizes lies spread out among all three clusters, with a focus on Clusters 1 and 3. The picture here is therefore not as clear as in the two cluster analyses presented above.

Location/growth clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	13	76,5%	2	25,0%	2	20,0%	9	56,3%	2	28,6%
	2	4	23,5%	6	75,0%	8	80,0%	7	43,8%	5	71,4%
	Combined	17	100,0%	8	100,0%	10	100,0%	16	100,0%	7	100,0%

Growth group

		Fast		Medium		Negative		Slow		Zero	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	12	100,0%	10	100,0%	0	,0%	0	,0%	6	100,0%
	2	0	,0%	0	,0%	4	100,0%	26	100,0%	0	,0%
	Combined	12	100,0%	10	100,0%	4	100,0%	26	100,0%	6	100,0%

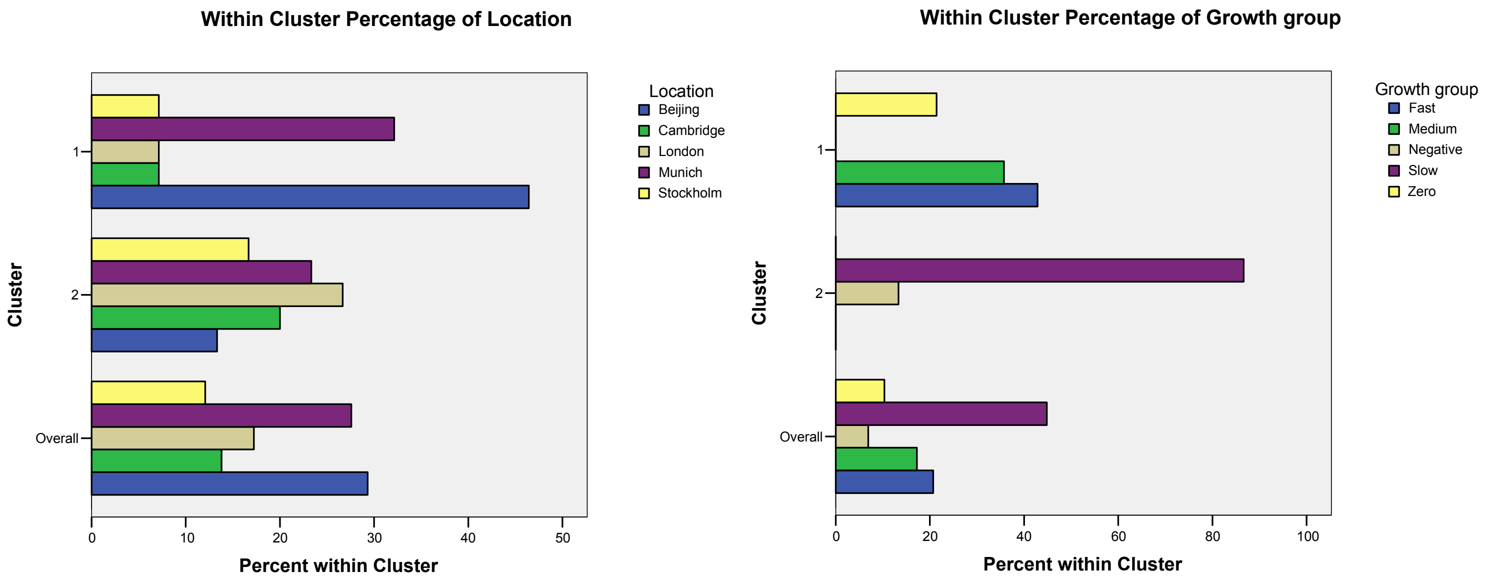


Figure 74: Two-step cluster analysis of location and facility growth

Beijing lies for the most part in Cluster 1, Cambridge and London for the most part in Cluster 2, Munich almost equally divided between the two clusters, and Stockholm for the most part in Cluster 2. From the growth perspective, Cluster 1 consists mainly of fast and medium growth facilities, whereas Cluster 2 consists of only slow and negative growth facilities.

Location/size of key partner network clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	8	53,3%	0	,0%	2	50,0%	7	46,7%	5	100,0%
	2	7	46,7%	2	100,0%	2	50,0%	8	53,3%	0	,0%
	Combined	15	100,0%	2	100,0%	4	100,0%	15	100,0%	5	100,0%

Size of key network group

		0-5		11-20		21-30		31+		6-10	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	2	9,5%	5	100,0%	3	100,0%	1	100,0%	11	100,0%
	2	19	90,5%	0	,0%	0	,0%	0	,0%	0	,0%
	Combined	21	100,0%	5	100,0%	3	100,0%	1	100,0%	11	100,0%

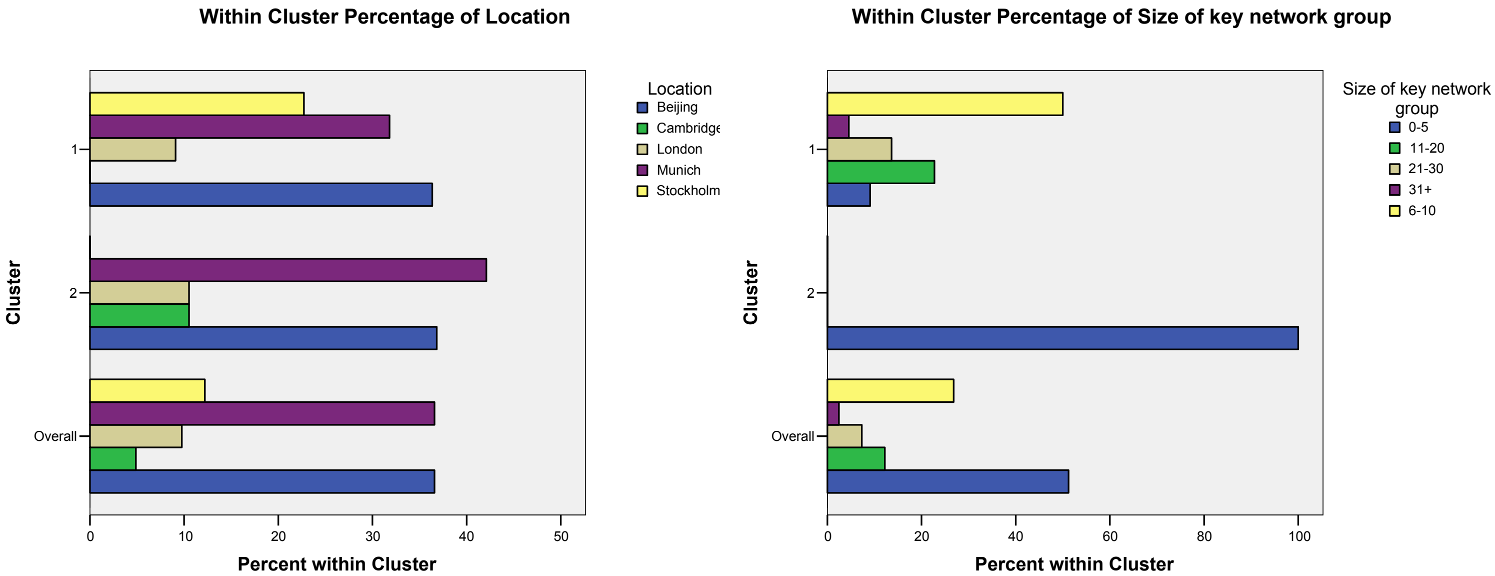


Figure 75. Two-step cluster analysis of location and size of key partner network

Beijing is divided equally between Clusters 1 and 2, Cambridge lies fully within Cluster 2, Stockholm lies fully within Cluster 1, whereas London and Munich are also equally divided between the two clusters. From the perspective of network size, Cluster 1 is dominated by the two categories ‘6-10’ and ’11-20’ collaboration partners. Cluster 2 is dominated by the ‘0-5’ key collaboration partners category.

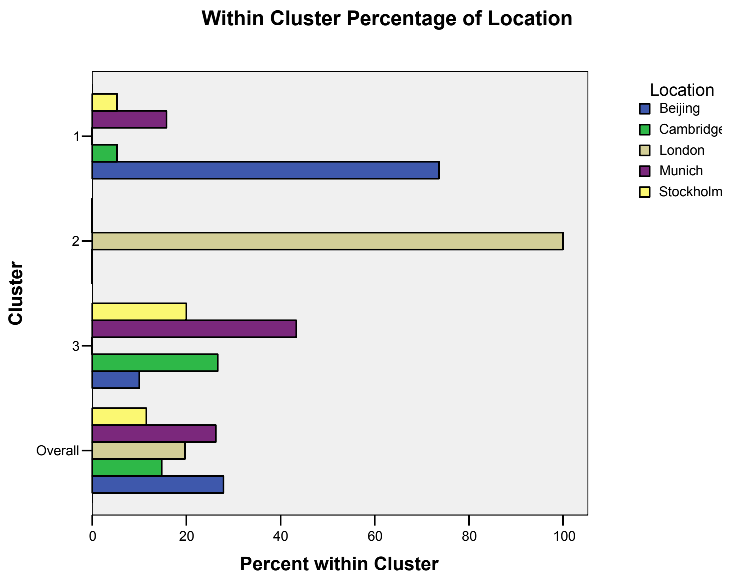
Location/manager nationality clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	14	82,4%	1	11,1%	0	,0%	3	18,8%	1	14,3%
	2	0	,0%	0	,0%	12	100,0%	0	,0%	0	,0%
	3	3	17,6%	8	88,9%	0	,0%	13	81,3%	6	85,7%
	Combined	17	100,0%	9	100,0%	12	100,0%	16	100,0%	7	100,0%

Manager nationality group

		1		2		3	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	11	68,8%	8	100,0%	0	,0%
	2	5	31,3%	0	,0%	7	18,9%
	3	0	,0%	0	,0%	30	81,1%
	Combined	16	100,0%	8	100,0%	37	100,0%



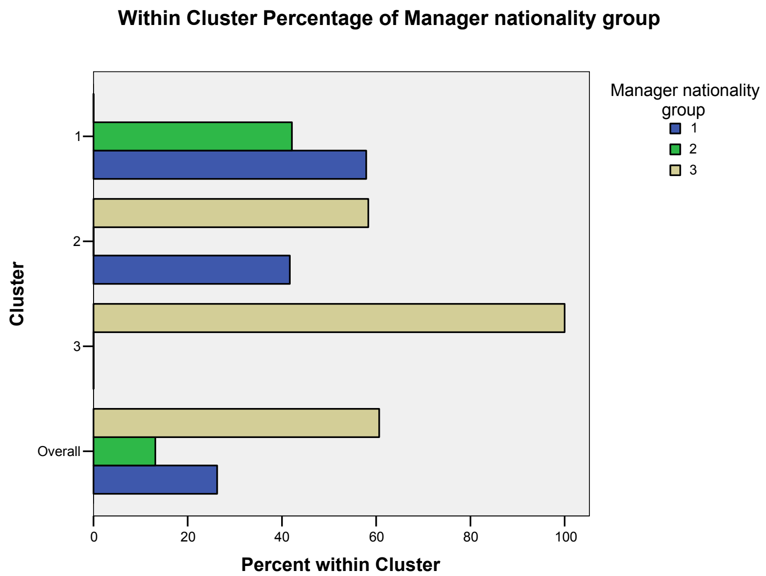


Figure 76: Two-step cluster analysis of location and manager nationality

Beijing for the most part lies in Cluster 1, Cambridge lies in Cluster 3, London lies in Cluster 2, Munich for the most part lies in Cluster 3, as does Stockholm. From the manager nationality perspective, Cluster 1 is dominated by manager nationality types 1 (home country nationality) and 2 (dual nationality types), Cluster 2 is dominated by types 1 and 3 (host country nationality), whereas Cluster 3 consists exclusively of type 3 manager nationalities.

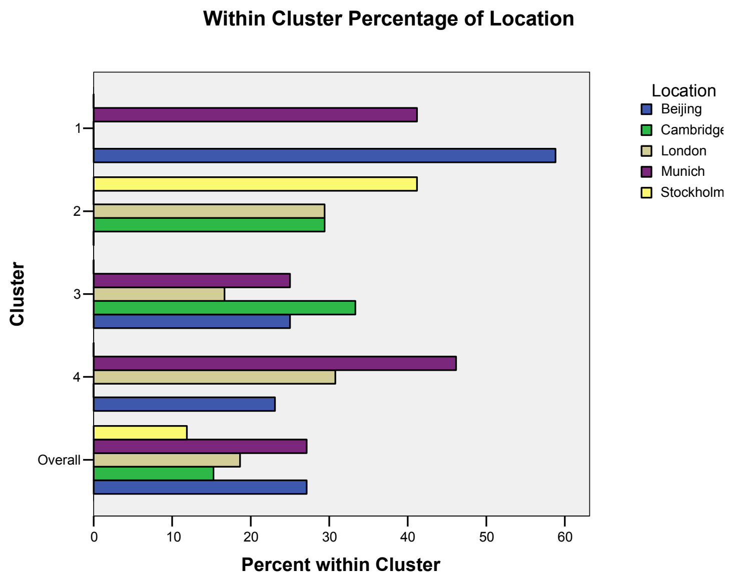
Location/explorative vs. exploitative clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	10	62,5%	0	,0%	0	,0%	7	43,8%	0	,0%
	2	0	,0%	5	55,6%	5	45,5%	0	,0%	7	100,0%
	3	3	18,8%	4	44,4%	2	18,2%	3	18,8%	0	,0%
	4	3	18,8%	0	,0%	4	36,4%	6	37,5%	0	,0%
	Combined	16	100,0%	9	100,0%	11	100,0%	16	100,0%	7	100,0%

Explorative vs. exploitative

		High		Low		Mid	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	17	54,8%	0	,0%	0	,0%
	2	14	45,2%	2	14,3%	1	7,1%
	3	0	,0%	12	85,7%	0	,0%
	4	0	,0%	0	,0%	13	92,9%
	Combined	31	100,0%	14	100,0%	14	100,0%



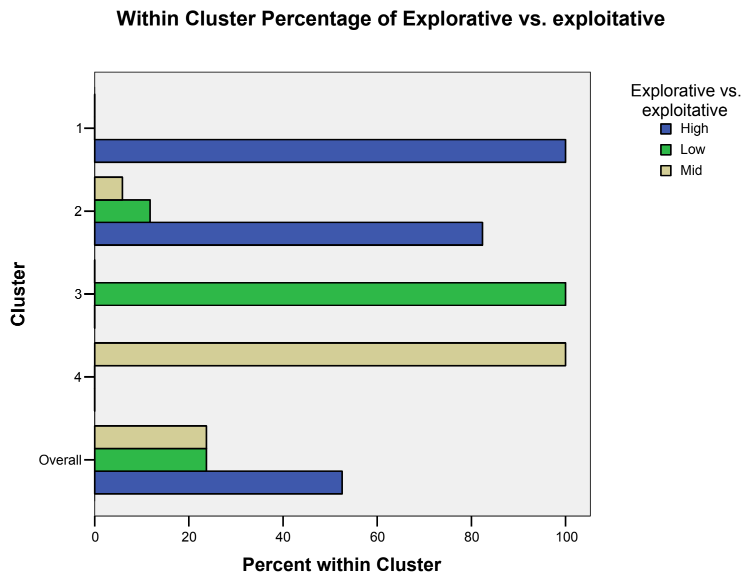


Figure 77: Two-step cluster analysis of location and explorative vs. exploitative

Beijing is divided between Clusters 1, 3 and 4 (with a majority in Cluster 1), Cambridge is divided almost equally between Clusters 2 and 3, London is divided between Clusters 2, 3, and 4, Munich between Clusters 1, 3, and 4, whereas Stockholm is present exclusively in Cluster 2. From the perspective of 'explorative vs. exploitative', Cluster 1 consists exclusively of highly exploitative work, Cluster 2 consists mainly of highly exploitative work, with elements of explorative work, Cluster 3 consists exclusively of explorative work, whereas Cluster 4 consists of work in the midrange of explorative/exploitative combinations.

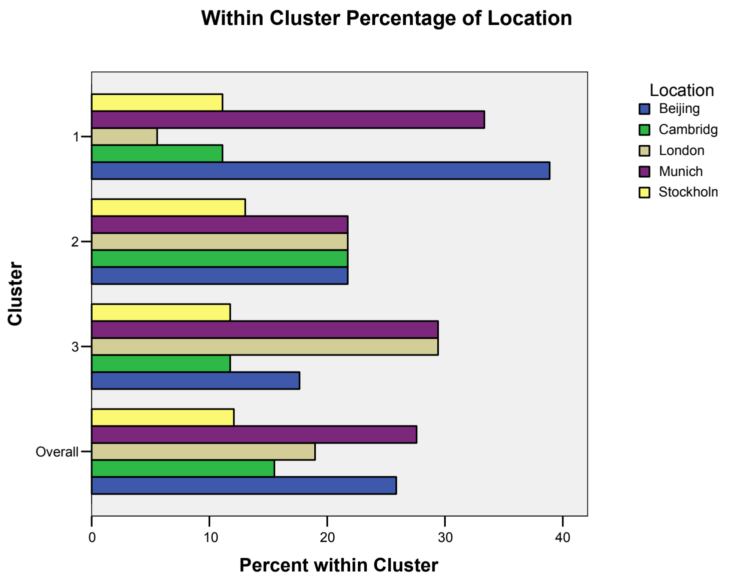
Location/collaborative vs. proprietary clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	7	46,7%	2	22,2%	1	9,1%	6	37,5%	2	28,6%
	2	5	33,3%	5	55,6%	5	45,5%	5	31,3%	3	42,9%
	3	3	20,0%	2	22,2%	5	45,5%	5	31,3%	2	28,6%
	Combined	15	100,0%	9	100,0%	11	100,0%	16	100,0%	7	100,0%

Collaborative vs. proprietary

		High		Low		Mid	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	0	,0%	18	100,0%	0	,0%
	2	23	100,0%	0	,0%	0	,0%
	3	0	,0%	0	,0%	17	100,0%
	Combined	23	100,0%	18	100,0%	17	100,0%



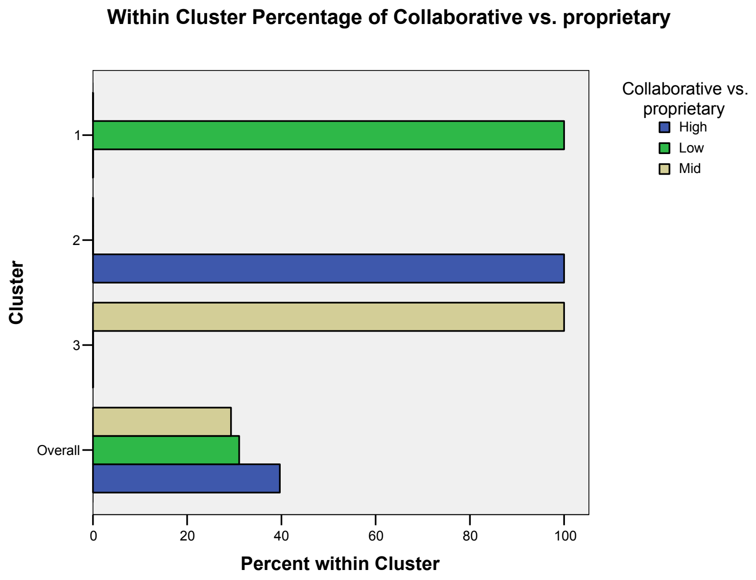


Figure 78: Two-step cluster analysis of location and collaborative vs. proprietary

All five locations are spread throughout the three clusters. From the 'collaborative vs. proprietary' perspective, Cluster 1 contains the collaborative facilities, Cluster 2 contains the proprietary facilities. Cluster 3 contains the facilities claiming both collaborative and proprietary approaches.

Location/single scientist to collaborate with clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	14	87,5%	0	,0%	0	,0%	0	,0%	0	,0%
	2	2	12,5%	4	100,0%	1	14,3%	2	13,3%	3	42,9%
	3	0	,0%	0	,0%	0	,0%	13	86,7%	0	,0%
	4	0	,0%	0	,0%	6	85,7%	0	,0%	4	57,1%
	Combined	16	100,0%	4	100,0%	7	100,0%	15	100,0%	7	100,0%

Single scientist

		High		Low		Medium	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	0	,0%	14	36,8%	0	,0%
	2	9	100,0%	1	2,6%	2	100,0%
	3	0	,0%	13	34,2%	0	,0%
	4	0	,0%	10	26,3%	0	,0%
	Combined	9	100,0%	38	100,0%	2	100,0%

Figure 79: Two-step cluster analysis of location and single scientist to collaborate with

Beijing for the most part lies within Cluster 1, Cambridge lies in Cluster 2, London for the most part lies in Cluster 4, Munich for the most part belongs to Cluster 3, and Stockholm lies divided between Clusters 2 and 4. From the perspective of single scientists playing key roles in the location decision, high and medium relevance of single scientists were recorded in Cluster 2, while low relevance of scientists was recorded equally in Clusters 1, 3, and 4.

Location/university institute to collaborate with clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	8	50,0%	4	100,0%	2	28,6%	2	13,3%	1	14,3%
	2	8	50,0%	0	,0%	5	71,4%	0	,0%	6	85,7%
	3	0	,0%	0	,0%	0	,0%	13	86,7%	0	,0%
	Combined	16	100,0%	4	100,0%	7	100,0%	15	100,0%	7	100,0%

Single university institute

		High		Low		Medium	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	14	100,0%	0	,0%	3	100,0%
	2	0	,0%	19	59,4%	0	,0%
	3	0	,0%	13	40,6%	0	,0%
	Combined	14	100,0%	32	100,0%	3	100,0%

Figure 80: Two-step cluster analysis of location and single university institute

Beijing is equally divided between Clusters 1 and 2, Cambridge is in Cluster 1, London for the most part lies in Cluster 2, Munich lies for the most part in Cluster 3, and Stockholm lies for the most part in Cluster 2. From the perspective of single university institutes playing an important role in location decisions, medium and high relevance were recorded in Cluster 1, while low relevance was recorded in Clusters 2 and 3.

Location/company to collaborate with clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	9	56,3%	0	,0%	0	,0%	0	,0%	3	60,0%
	2	0	,0%	2	100,0%	4	100,0%	10	66,7%	0	,0%
	3	7	43,8%	0	,0%	0	,0%	5	33,3%	2	40,0%
	Combined	16	100,0%	2	100,0%	4	100,0%	15	100,0%	5	100,0%

Specific company to collaborate with

		High		Low		Medium	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	0	,0%	12	48,0%	0	,0%
	2	2	20,0%	13	52,0%	1	14,3%
	3	8	80,0%	0	,0%	6	85,7%
	Combined	10	100,0%	25	100,0%	7	100,0%

Figure 81: Two-step cluster analysis of location and specific company to collaborate with

Beijing is spread equally between Clusters 1 and 3, Cambridge and London lie in Cluster 2, two-thirds of Munich facilities lie in Cluster 2, the rest in Cluster 3, while Stockholm is spread more or less equally between Clusters 1 and 3. From the perspective of specific companies to collaborate with playing a key role in location decisions, high relevance is recorded mainly in Cluster 3, low relevance is equally recorded in both Clusters 1 and 2, while medium relevance is recorded mainly in Cluster 3.

Location/company to be acquired clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	14	87,5%	0	,0%	0	,0%	0	,0%	0	,0%
	2	2	12,5%	1	25,0%	3	42,9%	4	26,7%	4	57,1%
	3	0	,0%	3	75,0%	4	57,1%	0	,0%	3	42,9%
	4	0	,0%	0	,0%	0	,0%	11	73,3%	0	,0%
	Combined	16	100,0%	4	100,0%	7	100,0%	15	100,0%	7	100,0%

Specific company to be acquired

		High		Low		Medium	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	0	,0%	14	40,0%	0	,0%
	2	12	100,0%	0	,0%	2	100,0%
	3	0	,0%	10	28,6%	0	,0%
	4	0	,0%	11	31,4%	0	,0%
	Combined	12	100,0%	35	100,0%	2	100,0%

Figure 82: Two-step cluster analysis of location and specific company to be acquired

Beijing for the most part lies in Cluster 1, Cambridge for the most part lies in Cluster 3, London and Stockholm lie divided more or less equally between Clusters 2 and 3, and Munich for the most part lies in Cluster 4. From the perspective of specific companies to acquire playing key roles in location decisions, medium to high relevance was recorded in Cluster 2, while low relevance was recorded almost equally in Clusters 1, 3, and 4.

Location/foreign technology region clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	9	56,3%	0	,0%	0	,0%	7	46,7%	0	,0%
	2	4	25,0%	1	25,0%	0	,0%	2	13,3%	3	42,9%
	3	0	,0%	0	,0%	7	100,0%	0	,0%	4	57,1%
	4	3	18,8%	3	75,0%	0	,0%	6	40,0%	0	,0%
	Combined	16	100,0%	4	100,0%	7	100,0%	15	100,0%	7	100,0%

Leading foreign technology region

		High		Low		Medium	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	0	,0%	16	88,9%	0	,0%
	2	0	,0%	0	,0%	10	100,0%
	3	9	42,9%	2	11,1%	0	,0%
	4	12	57,1%	0	,0%	0	,0%
	Combined	21	100,0%	18	100,0%	10	100,0%

Figure 83. Two-step cluster analysis of location and leading foreign technology region

Beijing for the most part lies in Clusters 1 and 2, Cambridge for the most part lies in Cluster 4, Munich lies divided more or less equally between Clusters 1 and 4, London lies in Cluster 3, while Stockholm lies divided more or less equally between Clusters 2 and 3. From the perspective of the quality of the technology region playing a key role in location decisions, high relevance was recorded in Clusters 3 and 4, low relevance was recorded mainly in Cluster 1, while medium relevance was recorded in Cluster 2.

Location/important foreign market potential clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	15	93,8%	1	25,0%	4	57,1%	10	66,7%	1	14,3%
	2	1	6,3%	3	75,0%	3	42,9%	5	33,3%	6	85,7%
	Combined	16	100,0%	4	100,0%	7	100,0%	15	100,0%	7	100,0%

Important foreign market potential

		High		Low		Medium	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	31	100,0%	0	,0%	0	,0%
	2	0	,0%	9	100,0%	9	100,0%
	Combined	31	100,0%	9	100,0%	9	100,0%

Figure 84: Two-step cluster analysis of location and important foreign market potential

Beijing lies in Cluster 1, Cambridge lies mainly in Cluster 2 (75 percent) and in Cluster 1 (25 percent), London is divided evenly between Clusters 1 and 2, Munich lies mainly in Cluster 1 (75 percent) and Cluster 2 (25 percent). Stockholm lies mainly in Cluster 2 (86 percent) and in Cluster 1 (14 percent). From the perspective of foreign market potential acting as a key driver in the location decision, high relevance was recorded in Cluster 1, while low and medium relevance was recorded in Cluster 2.

Location/attractive local labor market clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	14	87,5%	0	,0%	0	,0%	0	,0%	0	,0%
	2	2	12,5%	0	,0%	4	100,0%	0	,0%	5	100,0%
	3	0	,0%	2	100,0%	0	,0%	5	33,3%	0	,0%
	4	0	,0%	0	,0%	0	,0%	10	66,7%	0	,0%
	Combined	16	100,0%	2	100,0%	4	100,0%	15	100,0%	5	100,0%

Attractive local labor market

		High		Low		Medium	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	14	63,6%	0	,0%	0	,0%
	2	4	18,2%	7	41,2%	0	,0%
	3	4	18,2%	0	,0%	3	100,0%
	4	0	,0%	10	58,8%	0	,0%
	Combined	22	100,0%	17	100,0%	3	100,0%

Figure 85: Two-step cluster analysis of location and attractive local labor market

Beijing facilities are located mainly in Cluster 1, Cambridge facilities are mainly located in Cluster 3, London and Stockholm facilities are located in Cluster 2, Munich facilities are mainly located in Cluster 4 (75 percent) and Cluster 3 (25 percent). From the perspective of the attractiveness of the labor market playing a key role in location processes, high relevance was recorded mainly in Cluster 1 (64 percent) but also in Clusters 2 (18 percent) and 3 (18 percent), medium relevance was recorded in Cluster 3, and low relevance was recorded more or less equally in Clusters 2 and 4.

Location/universities clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	3	20,0%	0	,0%	1	9,1%	4	25,0%	1	14,3%
	2	3	20,0%	0	,0%	2	18,2%	2	12,5%	2	28,6%
	3	0	,0%	9	100,0%	0	,0%	0	,0%	0	,0%
	4	9	60,0%	0	,0%	0	,0%	0	,0%	0	,0%
	5	0	,0%	0	,0%	8	72,7%	0	,0%	4	57,1%
	6	0	,0%	0	,0%	0	,0%	10	62,5%	0	,0%
	Combined	15	100,0%	9	100,0%	11	100,0%	16	100,0%	7	100,0%

Universities

		High		Low		Medium	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	0	,0%	0	,0%	9	81,8%
	2	0	,0%	9	90,0%	0	,0%
	3	6	16,2%	1	10,0%	2	18,2%
	4	9	24,3%	0	,0%	0	,0%
	5	12	32,4%	0	,0%	0	,0%
	6	10	27,0%	0	,0%	0	,0%
	Combined	37	100,0%	10	100,0%	11	100,0%

Figure 86: Two-step cluster analysis of location and universities

Beijing lies in Clusters 4 (60 percent), Cluster 1 (20 percent), and Cluster 2 (20 percent). Cambridge lies in Cluster 3, London lies in Clusters 5 (73 percent), 2 (18 percent), and 1 (9 percent), Munich lies in Clusters 6 (25 percent), 1 (25 percent), and 2 (13 percent). Stockholm lies in Clusters 5 (57 percent), 1 (14 percent), and 2 (29 percent). From the perspective of universities playing an important role as collaboration partners in the integration process, high relevance was recorded in Clusters 3 (16 percent), 4 (24 percent), 5 (32 percent), and 6 (27 percent), medium relevance was recorded in Clusters 1 (82 percent) and 3 (18 percent), and low relevance was recorded in Clusters 2 (90 percent) and 3 (10 percent).

Location/state research labs clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	8	53,3%	1	11,1%	6	54,5%	11	68,8%	0	,0%
	2	7	46,7%	8	88,9%	5	45,5%	5	31,3%	7	100,0%
	Combined	15	100,0%	9	100,0%	11	100,0%	16	100,0%	7	100,0%

State research labs

		High		Low		Medium	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	26	100,0%	0	,0%	0	,0%
	2	0	,0%	24	100,0%	8	100,0%
	Combined	26	100,0%	24	100,0%	8	100,0%

Figure 87: Two-step cluster analysis of location and state research labs

Beijing and London are more or less equally divided between Clusters 1 and 2, Cambridge lies mainly in Cluster 2 while Stockholm lies completely in Cluster 2. Munich on the other hand lies in Cluster 1 (69 percent) and Cluster 2 (31 percent). From the perspective of the importance of state research labs as collaboration partners in the integration process, high relevance was recorded in Cluster 1, while low and medium relevance was recorded in Cluster 2.

Location/lead customer companies clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	14	87,5%	0	,0%	0	,0%	16	100,0%	5	71,4%
	2	2	12,5%	9	100,0%	11	100,0%	0	,0%	2	28,6%
	Combined	16	100,0%	9	100,0%	11	100,0%	16	100,0%	7	100,0%

Lead customer companies

		High		Low		Medium	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	23	79,3%	12	54,5%	0	,0%
	2	6	20,7%	10	45,5%	8	100,0%
	Combined	29	100,0%	22	100,0%	8	100,0%

Figure 88: Two-step cluster analysis of location and lead customer companies

Beijing lies mainly in Cluster 1, as do Munich and Stockholm. Cambridge and London lie fully in Cluster 2. From the perspective of the importance of lead customer companies as collaboration partners in the integration process, high relevance was recorded mainly in Cluster 1, while medium relevance was recorded only in Cluster 2. Low relevance was recorded equally in both clusters.

Location/supplier/vendor clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	9	56,3%	7	77,8%	6	54,5%	0	,0%	0	,0%
	2	7	43,8%	2	22,2%	5	45,5%	0	,0%	7	100,0%
	3	0	,0%	0	,0%	0	,0%	16	100,0%	0	,0%
	Combined	16	100,0%	9	100,0%	11	100,0%	16	100,0%	7	100,0%

Supplier/vendor companies

		High		Low		Medium	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	0	,0%	22	81,5%	0	,0%
	2	13	56,5%	2	7,4%	6	66,7%
	3	10	43,5%	3	11,1%	3	33,3%
	Combined	23	100,0%	27	100,0%	9	100,0%

Figure 89: Two-step cluster analysis of location and supplier/vendor companies

Beijing and London are more or less equally divided between Clusters 1 and 2. Cambridge lies for the most part in Cluster 1 (78 percent) and in Cluster 2 (22 Percent). Munich lies in Cluster 3, and Stockholm lies in Cluster 2. From the perspective of the importance of supplier/vendor companies as collaboration partners, high relevance is recorded in Clusters 2 and 3, medium relevance in recorded in Clusters 2 (67 percent) and 3 (33 percent), while low relevance is primarily recorded in Cluster 1.

Location/complementary technology company clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	16	100,0%	0	,0%	0	,0%	16	100,0%	0	,0%
	2	0	,0%	9	100,0%	11	100,0%	0	,0%	7	100,0%
	Combined	16	100,0%	9	100,0%	11	100,0%	16	100,0%	7	100,0%

Complementary techn companies

		High		Low		Medium	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	12	60,0%	15	57,7%	5	38,5%
	2	8	40,0%	11	42,3%	8	61,5%
	Combined	20	100,0%	26	100,0%	13	100,0%

Figure 90: Two-step cluster analysis of location and complementary technology companies

Beijing and Munich belong fully to Cluster 1, while Cambridge, London, and Stockholm belong fully to Cluster 2. From the perspective of the importance of complementary technology companies as collaboration partners for the integration process, high relevance is attributed to Cluster 1 (60 percent) and Cluster 2 (40 percent). Medium importance is attributed to Cluster 2 (62 percent) and Cluster 1 (38 percent), while low importance is attributed to Cluster 1 (58 percent) and Cluster 2 (42 percent).

Location/competitor company clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	12	75,0%	7	77,8%	0	,0%	0	,0%	5	71,4%
	2	0	,0%	0	,0%	8	72,7%	12	75,0%	0	,0%
	3	4	25,0%	2	22,2%	3	27,3%	4	25,0%	2	28,6%
	Combined	16	100,0%	9	100,0%	11	100,0%	16	100,0%	7	100,0%

Competitor companies

		High		Low		Medium	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	0	,0%	24	58,5%	0	,0%
	2	3	100,0%	17	41,5%	0	,0%
	3	0	,0%	0	,0%	15	100,0%
	Combined	3	100,0%	41	100,0%	15	100,0%

Figure 91: Two-step cluster analysis of location and competitor companies

Beijing, Cambridge, and Stockholm belong primarily to Cluster 1, while London and Munich belong primarily to Cluster 2. All locations had between 25 and 30 percent of their facilities in

Cluster 3. From the perspective of the importance of collaborating with competitor companies, high relevance was recorded in Cluster 2, medium relevance was recorded in Cluster 3, while low relevance was recorded in Cluster 1 (59 percent) and Cluster 2 (41 percent).

Location/R&D manager personal networks clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	13	81,3%	0	,0%	0	,0%	0	,0%	0	,0%
	2	3	18,8%	1	11,1%	2	18,2%	4	25,0%	1	14,3%
	3	0	,0%	8	88,9%	0	,0%	0	,0%	6	85,7%
	4	0	,0%	0	,0%	9	81,8%	12	75,0%	0	,0%
	Combined	16	100,0%	9	100,0%	11	100,0%	16	100,0%	7	100,0%

Mgr. personal

		High		Low		Medium	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	13	27,1%	0	,0%	0	,0%
	2	0	,0%	6	100,0%	5	100,0%
	3	14	29,2%	0	,0%	0	,0%
	4	21	43,8%	0	,0%	0	,0%
	Combined	48	100,0%	6	100,0%	5	100,0%

Figure 92: Two-step cluster analysis of location and manager personal networks

Beijing is located mainly in Cluster 1, Cambridge in Cluster 3, London and Munich in Cluster 4, and Stockholm in Cluster 3. From the perspective of the importance of manager personal networks for the integration process, high relevance was recorded similarly in Clusters 1, 3, and 4. Medium and low relevance was recorded in Cluster 2.

Location/employee personal networks clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	16	100,0%	0	,0%	0	,0%	16	100,0%	0	,0%
	2	0	,0%	9	100,0%	11	100,0%	0	,0%	7	100,0%
	Combined	16	100,0%	9	100,0%	11	100,0%	16	100,0%	7	100,0%

Empl. personal

		High		Low		Medium	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	28	51,9%	3	100,0%	1	50,0%
	2	26	48,1%	0	,0%	1	50,0%
	Combined	54	100,0%	3	100,0%	2	100,0%

Figure 93: Two-step cluster analysis of location and employee personal networks

The result here is very similar to that of the analysis of the manager personal networks conducted above. Each of the locations showed high and medium relevance of employee personal networks.

Location/home country manager personal networks clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	12	75,0%	5	62,5%	5	45,5%	8	50,0%	3	42,9%
	2	4	25,0%	3	37,5%	6	54,5%	8	50,0%	4	57,1%
	Combined	16	100,0%	8	100,0%	11	100,0%	16	100,0%	7	100,0%

Home country mgr personal

		High		Low		Medium	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	22	100,0%	0	,0%	11	100,0%
	2	0	,0%	25	100,0%	0	,0%
	Combined	22	100,0%	25	100,0%	11	100,0%

Figure 94: Two-step cluster analysis of location and home country mgr. personal networks

Beijing and Cambridge tend towards Cluster 1, while London, Munich, and Stockholm are more or less equally divided between Clusters 1 and 2. In terms of the importance of home country manager networks for regional integration, high and medium importance were recorded in Cluster 1, while low importance was recorded in Cluster 2.

Location/consultant networks clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	16	100,0%	0	,0%	9	81,8%	0	,0%	0	,0%
	2	0	,0%	9	100,0%	2	18,2%	16	100,0%	7	100,0%
	Combined	16	100,0%	9	100,0%	11	100,0%	16	100,0%	7	100,0%

Consultant

		High		Low		Medium	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	0	,0%	15	42,9%	10	66,7%
	2	9	100,0%	20	57,1%	5	33,3%
	Combined	9	100,0%	35	100,0%	15	100,0%

Figure 95: Two-step cluster analysis of location and consultant networks

Beijing and London belong to Cluster 1, while Cambridge, Munich, and Stockholm belong to Cluster 2. In terms of consultant networks playing important roles in the integration process, high relevance was recorded in Cluster 2, low importance was recorded more or less equally in Clusters 1 and 2, and medium importance was recorded mainly in Cluster 1 (67 percent) and in Cluster 2 (33 percent).

Location/government matchmaking networks clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	9	56,3%	0	,0%	4	36,4%	5	31,3%	1	14,3%
	2	7	43,8%	0	,0%	0	,0%	11	68,8%	6	85,7%
	3	0	,0%	9	100,0%	7	63,6%	0	,0%	0	,0%
	Combined	16	100,0%	9	100,0%	11	100,0%	16	100,0%	7	100,0%

Gov. matchmaking

		High		Low		Medium	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	13	100,0%	0	,0%	6	100,0%
	2	0	,0%	24	60,0%	0	,0%
	3	0	,0%	16	40,0%	0	,0%
	Combined	13	100,0%	40	100,0%	6	100,0%

Figure 96: Two-step cluster analysis of location and government matchmaking networks

Beijing is more or less equally divided between Clusters 1 and 2, Cambridge lies completely in Cluster 3, London lies mainly in Cluster 3 (64 percent) and in Cluster 1 (36 percent), Munich lies mainly in Cluster 2 (69 percent) and in Cluster 1 (31 percent). Stockholm lies mainly in Cluster 2 (86 percent) and in Cluster 1 (14 percent).

Location/industrial club networks clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	10	62,5%	6	66,7%	8	72,7%	11	68,8%	3	42,9%
	2	6	37,5%	3	33,3%	3	27,3%	5	31,3%	4	57,1%
	Combined	16	100,0%	9	100,0%	11	100,0%	16	100,0%	7	100,0%

Industrial club

		High		Low		Medium	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	28	100,0%	0	,0%	10	100,0%
	2	0	,0%	21	100,0%	0	,0%
	Combined	28	100,0%	21	100,0%	10	100,0%

Figure 97: Two-step cluster analysis of location and industrial club networks

Each of the regions except Stockholm was present in both clusters but with a tendency towards Cluster 1. Stockholm displayed a slight tendency towards Cluster 2.

Location/non-industrial networks clusters

Location

		Beijing		Cambridge		London		Munich		Stockholm	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	12	75,0%	6	66,7%	0	,0%	0	,0%	6	85,7%
	2	4	25,0%	3	33,3%	1	9,1%	5	31,3%	1	14,3%
	3	0	,0%	0	,0%	10	90,9%	11	68,8%	0	,0%
	Combined	16	100,0%	9	100,0%	11	100,0%	16	100,0%	7	100,0%

Non-industrial club

		High		Low		Medium	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	0	,0%	24	53,3%	0	,0%
	2	7	100,0%	0	,0%	7	100,0%
	3	0	,0%	21	46,7%	0	,0%
	Combined	7	100,0%	45	100,0%	7	100,0%

Figure 98: Two-step cluster analysis of location and non-industrial club networks

Beijing, Cambridge, and Stockholm are each divided between Clusters 1 and 2 with a clear tendency towards Cluster 1. London and Munich are divided between Clusters 2 and 3 with a clear tendency towards Cluster 3.