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Internationalization of Industrial R&D in Emerging Economies

Concept and Empirical Evidence
from the German Manufacturing Industry

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List of Abbreviations

ASEAN	Association of Southeast Asian Nations
BRIC	Brazil, Russia, India, and China
CEO	Chief executive officer
Cont'd	Continued
CTU	Corporate Technology Unit
EM	Emerging market
EU	European Union
EIU	Economist Intelligence Unit
EUR	Euro
FDI	Foreign direct investment
FTE	Full-time equivalent
G7	Group of Seven (industrialized nations)
GDP	Gross domestic product
GNI	Gross national income
GI	Global Innovation (as R&D configuration strategy)
GIC	Delegation of German Industry and Commerce in Shanghai
GTCC	German-Thai Chamber of Commerce
GTU	Global Technology Unit
HBA	Home-base augmenting (as motive for FDI in R&D)
HBE	Home-base exploiting (as motive for FDI in R&D)
HDI	Human development index

HHD	High human development country
HIC	High income country
HR	Human resources
IB	International business
IGCC	Indo-German Chamber of Industry and Commerce
IMF	International Monetary Fund
IMP	Implementation (as R&D configuration strategy)
IPLC	International product life cycle
IPR	Intellectual property rights
ITU	Indigenous Technology Unit
LHD	Low human development country
LI	Local Innovation (as R&D configuration strategy)
LIC	Low income country
LIL	Locally Integrated Laboratory
LISREL	Linear structural relationships
LMI	Lower middle income country
m	Million
MHD	Middle human development country
MNC	Multinational corporation
MNE	Multinational enterprise
n.s.	Not significant
n.a.	Not applicable

OPAC	Online Public Access Catalogue
PLS	Partial least squares
PPP	Purchasing power parity
R&D	Research & development
RBV	Resource-based view
SEM	Structural equation modeling
SGC	Singaporean-German Chamber of Industry and Commerce
SIC	Standard Industrial Classification
SL	Support Laboratory
SME	Small and medium-sized enterprises
SPSS	Statistical Package for the Social Sciences
TNC	Transnational corporation
TTU	Transfer Technology Unit
UMI	Upper middle income country
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
U.S.	United States
US$	United States Dollar
VDP	Variance-decomposition proportion
VIF	Variance inflation factor
WTO	World Trade Organization
†, *, **, ***	Significance levels of 10%, 5%, 1%, and 0.1%, respectively

1 Motivation

Growing international competition, an accelerating pace of technological advancements, and increasingly demanding, fragmented, and volatile customer preferences present firms in today's business environment with a major challenge: They have to manage the dilemma of decreasing product life cycles and high pressure to develop commercially viable products and services faster on the one hand and increasing development costs and risks for new technologies on the other (Howells 2008; Lanjouw and Schankerman 2004; OECD 1991). Accordingly, their ability to identify new technology and market trends worldwide and to globally exploit product, process, and strategy innovations faster, more efficiently, and with greater flexibility than competitors have become essential success factors for multinational enterprises (MNEs) (e.g., Blomkvist, Kappen, and Zander 2010; Franko 1989; Lewin, Massini, and Peeters 2009; Perlitz 1993).

These challenges not only are valid in industrialized countries but also are valid, and particularly so, in emerging economies. These countries have experienced tremendous development in the past few decades. Although at some point in the past it was still possible for Western MNEs to compete in these markets with outdated technology, increased customer sophistication and rising competitive pressure require companies to build on the latest technologies in these countries as well. The case of Volkswagen in China is a prominent anecdotal example that illustrates this change in the competitive environment: Volkswagen was the first foreign carmaker to enter the Chinese market. In 1985 Volkswagen started the production of the Santana sedan in its plant in Anting, near Shanghai. For almost ten years, Volkswagen's Santana ruled the roads of China. In Europe, the Santana was developed and built in the 1970s, but the model never found a large number of customers and production was finally stopped. In China, however, the Santana had no serious competitor to challenge Volkswagen's position as market leader until the mid 1990s. The firm's comfortable position as quasi-monopolist ended when an increasing number of foreign competitors entered the Chinese market in the late 1990s. These companies launched an increasing number of models that offered up-to-date technology and considered the

specific local tastes and thus could rapidly gain market share at Volkswagen's expense. As new car models came on the market, consumers became increasingly conscious of choices; their expectations and their price-consciousness rose. Volkswagen had to react and so invested heavily in local development capabilities. In cooperation with corporate research & development (R&D) in Germany, the Chinese subsidiary developed a new car model based on the specific needs and preferences of the Chinese market. From the beginning, more than 70 percent of all parts for the model were sourced from local suppliers.

Regarding the internationalization of business R&D, Manolopoulos, Papanastassiou, and Pearce (2007) assert that "[o]ne of the most pervasive and strategically significant developments in MNEs' global expansion in the past 30 years has been the quantitative growth of their dispersed R&D facilities" (p.662). In contrast to the management of other activities, such as marketing or manufacturing, MNEs traditionally have kept all major innovation activities centrally in their home country (see Ambos and Ambos 2009a; Creamer 1976; De Meyer and Mizushima 1989; Terpstra 1977). R&D usually represents one of the last objectives of an internationalization strategy (Patel and Pavitt 1991; Pearce 1989), which makes R&D "the least globalized of MNEs' value-adding activities" (Kumar 2001, p. 160). Compared to the internationalization of other functions, offshore R&D activities represent a much more recent phenomenon (Dunning and Lundan 2009; Feinberg and Gupta 2004). In recent decades the internationalization of R&D has rapidly gained momentum, with sharp increases in foreign direct investment (FDI) in R&D and growing numbers of R&D sites abroad (Dalton and Serapio 1999; Hakanson and Nobel 1993b; Reger, Beise, and Belitz 1999; Stifterverband 2010; Zedtwitz and Gassmann 2002). Foreign R&D expenditures of U.S. companies, for instance, increased by 25% between 1997 and 1999 (Gassmann and Gaso 2004). Most European countries experienced sharp increases in international R&D in the 1980s (Hakanson and Nobel 1993a). In German MNEs, international dispersion of R&D lagged behind this development and appears to be an even more recent phenomenon of the 1990s (Ambos 2005). In the previous ten years, German companies have established more foreign R&D units than they did

cumulatively in the preceding 50 years (UNCTAD 2005). Moreover, MNEs increasingly assign tasks to R&D facilities outside their home country that go well beyond simple adaptations for the respective local market. Foreign R&D units take on more and more international responsibilities and are increasingly integrated into the MNE's global innovation network. Instead of the traditional forward knowledge transfer, from headquarters to the foreign subsidiaries, there is an increase of lateral and reverse knowledge transfer, from the foreign subsidiaries to other affiliates or to headquarters in the home country (Ambos, Ambos, and Schlegelmilch 2006; Frost 1998; Hakanson and Nobel 2000, 2001; Kotabe et al. 2007). Accordingly, both the extent to which MNEs perform R&D outside their home countries and the types of foreign R&D have changed considerably (Song and Shin 2008, p.292).

While MNEs have located manufacturing plants in emerging countries for some time, R&D activities traditionally are highly concentrated in some technologically advanced countries and typically stay in relative proximity to the corporate headquarters (e.g., Ambos 2005; Gassmann and Zedtwitz 1999; Reger, Beise, and Belitz 1999). The main reason for this concentration is that R&D activities require a superior knowledge base with highly skilled labor, as well as a stable and predictable institutional environment favoring innovation. These requirements are traditionally met in industrialized countries with strong, national innovation systems. With the continuing globalization of value creation activities (Ghemawat 2003; Goerzen and Beamish 2003), more and more MNEs recognize a growing global supply of science and technology resources and capabilities, including attractive conditions for R&D activities in some emerging economies – from both the cost and the resource perspectives. Consequently, emerging market subsidiaries are considered an increasingly important asset for the innovative activities of MNEs (see Boehe 2008, p.29). About 15 years ago, Motorola was one of the first companies to establish a foreign-owned R&D laboratory in China. By now, with a network of 19 research centers and laboratories and 1,600 R&D engineers, the country has become the largest R&D location for Motorola outside the United States. Today, the total number of foreign R&D units in China reached about 700, and the trend toward international dispersion of R&D activities in emerging

economies is expected to further increase. In a recent survey, 61% of European firms declared that they intend to increase their foreign R&D, with China representing the top destination for R&D expansion, followed by the United States and then India, which ranks third worldwide as the most attractive R&D location (see EIU 2004; UNCTAD 2005).

In addition to its influence on the competitive position of individual firms, internationalization of business R&D – using the larger lens of the economic context of international technology transfer – can also be considered a key dimension of globalization, having a significant effect on the technological development of host countries and the competitiveness of nations in the global economy (Brockhoff 1999; Cheng and Bolon 1993; OECD 2008a; Pearce 1989). Accordingly, many countries have developed policy initiatives to stimulate innovation and to attract FDI in R&D (Hegde and Hicks 2008).

In a nutshell, two recent trends regarding the internationalization of innovation activities can be stated: first, an increasing share of foreign R&D in general, and second, the emergence and fast-paced growth of foreign R&D activities in emerging countries.

International management research has long neglected international R&D (Cantwell 1992; Cheng and Bolon 1993; Gassmann and Zedtwitz 1998; Granstrand, Hakanson, and Sjölander 1992), but now the field has moved up on the research agenda (Chiesa 2000; Manolopoulos, Papanastassiou, and Pearce 2005; Peng and Wang 2000). Until the late 1990s, research on R&D internationalization primarily focused on the economic and political levels or investigated location decisions on the project level. More recently, there is growing recognition of foreign subsidiary innovation (Cantwell and Mudambi 2005; Phene and Almeida 2008). Besides providing technical support to local sales and manufacturing functions in the host country,and adaptating existing products or processes technologies to local market requirements, foreign R&D units are increasingly integrated into their firm's global value creation network. A global mandate for a certain product or technology is one example. In this manner, foreign

R&D units develop their own distinctive technological knowledge and capabilities and leverage host-country advantages, such as factor costs and access to a superior knowledge base, and simultaneously can benefit from the interdependencies across the group (Papanastassiou and Pearce 1998; Pearce 1999).

This thesis aims to contribute to the literature on the internationalization of MNEs' R&D activities. A comprehensive literature review reveals that there is a need for additional research particularly linking the discussion of R&D internationalization to the field and theories of international business (IB) research. Addressing the identified lack of research on R&D in emerging economies, this study intends to expand the understanding of international R&D configuration in MNEs and to provide insights into the nature and motives of MNEs' R&D activities in emerging economies. The chosen focus, on the subsidiary level of activity, accommodates the upcoming and increasingly influential stream of literature in IB research taking a subsidiary view of the MNE (e.g., Andersson, Forsgren, and Holm 2002; Asmussen, Pedersen, and Dhanaraj 2009; Cantwell and Mudambi 2005; Frost, Birkinshaw, and Ensign 2002). Furthermore, researchers suggest that the innovative role of subsidiaries in MNEs has become significant in recent years (e.g., Kotabe et al. 2007; Phene and Almeida 2008).

Regarding R&D activities in emerging economies, there are few empirical insights and many open questions (see Ambos and Ambos 2009a). The first research question therefore addresses the configuration of subsidiaries' R&D activities and the corresponding subsidiary roles. Thus far, it is not clear how prevalent the location of R&D activities in emerging economies is or how these units are integrated into the global MNE network. Moreover, extant literature reveals that the configuration may differ across different contexts, including by industry and by host country and may also change over time (see, e.g., Van Ark et al. 2008). Therefore, the first research question which is addressed by the present work asks the following:

1a. Which R&D configuration strategies do foreign subsidiaries in emerging countries pursue?

1b. How do these strategies vary across different contexts and over time?

The second research question represents the central, confirmatory part of the thesis. It addresses different motives and their influence on the configuration of MNE subsidiary R&D in emerging economies. Analyzing location and industry factors, the thesis aims to explain and predict variations in subsidiary-level R&D activities (i.e., variations of knowledge transfer from and to a focal foreign affiliate). The second research question therefore asks:

2a. How do location factors relate to the choice of international R&D configuration in emerging countries?

2b. How do industry factors relate to the choice of international R&D configuration in emerging countries?

To address this research question, this study develops a conceptual framework building on prior studies on R&D internationalization and foundational IB theories. The framework is analyzed using structural equation modeling (SEM).

This thesis consists of eight chapters structured in three sections: conceptualization, methodology, and empirical results. Subsequent to this introduction, Chapter 2 introduces basic terms used throughout the study and describes the selection criteria applied for the literature review. Thereafter, a literature review provides an overview and discussion of relevant studies in the fields related to the subject of this thesis. On this basis, the research gap is derived, and the positioning of this study within the existing body of literature is illustrated. Chapter 3 describes the theoretical foundation of the research and outlines the reference theories that contribute to explain subsidiary R&D strategies and their determinants. Chapter 4 introduces the research framework of this study and develops hypotheses for the relationships based on theoretical considerations and existing conceptual and empirical findings.

The methodological part starts with Chapter 5, explaining the applied methodological

approach and describing the date collection procedure for the large-scale empirical survey, as well as the characteristics of the data sample. The collected sample is analyzed with respect to respondents' characteristics, representativeness, and biases. Subsequently, the chapter introduces the applied methodology of data analysis, describing the applied statistical methods, validation procedures, and fit criteria. Chapter 6 specifies the conceptualization and operationalization of the theoretical constructs and assesses the respective measurement models.

Chapter 7 answers the posed research questions. The first part of this chapter addresses the first research question in an exploratory manner and examines subsidiaries' R&D strategies in the emerging countries under consideration. The second part addresses the second research question and includes a discussion of the empirical testing of the previously derived hypotheses and the findings of the structural model. Finally, Chapter 8 summarizes the key findings of the study, outlines the academic contribution, points out avenues for further research, and derives implications for managerial practice.

2 Definitions, Literature Review, and Research Gap

This chapter comprises three sections. It starts with a definition of key terms that are of major relevance and applied throughout the thesis. This section aims to ensure a common understanding and to specify the scope and objective of the research project. The second section addresses the existing body of literature related to the research topic. A review and discussion of contributions in the relevant fields provide the basis for the research at hand. The third section summarizes the findings of the literature review, describing the identified research gap and the respective contributions of this research project.

2.1 Definition of Terms

In the following, four terms and synonymously applied expressions are introduced: international R&D, configuration, emerging economies, and subsidiary. These are fundamental and frequently used terms throughout this thesis. Therefore, the definition both creates a common understanding of fundamental and frequently used terms in this thesis and contributes to a further specification of the scope.

2.1.1 International R&D

There are many approaches in literature defining R&D, reaching back to Bush's (1945) work on R&D taxonomies (see Van Ark et al. 2008). Broadly, R&D is the combination of factors of production with the objective of generating new "knowledge" (Brockhoff 1999). Similarly, the Frascati Manual, the international guide for collecting and using R&D statistics, defines R&D as creative work "undertaken on a systematic basis in order to increase the stock of knowledge […] and the use of this stock of knowledge to devise new applications" (OECD 2002, p.30).

One common categorization distinguishes between basic research, applied research, and development (sometimes subdivided into product and process development).

According to OECD (2002, p.30), basic research is “experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view“. Applied research is “also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective“. In industry, applied research includes the creation of knowledge that has specific commercial objectives with regard to product, processes, or services (UNCTAD 2006). Development (or “experimental development”) describes “systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products, or devices; to installing new processes, systems, and services; or to improving substantially those already produced or installed“. While basic research is mainly undertaken by the public sector and plays only a marginal role in business R&D (UNCTAD 2005), the other two forms are central to the competitiveness of firms (Brockhoff 1999; Han, Kim, and Srivastava 1998). Cohen and Levinthal (1989) argue that firms have little incentive to carry out any basic research, except for their need to build absorptive capacity that allows them to use publicly available research results in their own R&D units. In practice, however, it has to be admitted that drawing a distinct line between the different types of R&D activities is difficult (UNCTAD 2005); in fact, according to Van Ark et al. (2008), “the precise line between research and development is not easily drawn“. Particularly in technology-intensive industries, there is a smooth transition between “research” and “development” because much of the R&D activities include close cooperation and interaction both between researchers in the private and public sectors and with customers and suppliers (Amsden and Tschang 2003). Actually, Van Arc et al. (2008, p.17) found that managers tend to consider both “applied research” and ”development” as defined by OECD (2002) as “development” rather than “research” because both activities are linked to practical objectives and commercial applications. Meanwhile, only “basic research” is regarded as “research” because of the absence of immediate application in commercially viable products (see Figure 1, adapted from Van Arc et al. 2008). Commes and Lienert (1983) emphasize that different risks are associated with different parts of the R&D process. In this perspective, wheter a step is

research or development depends on the the degree and type (e.g., technological, market, and financial) of risk assigned to the activity.

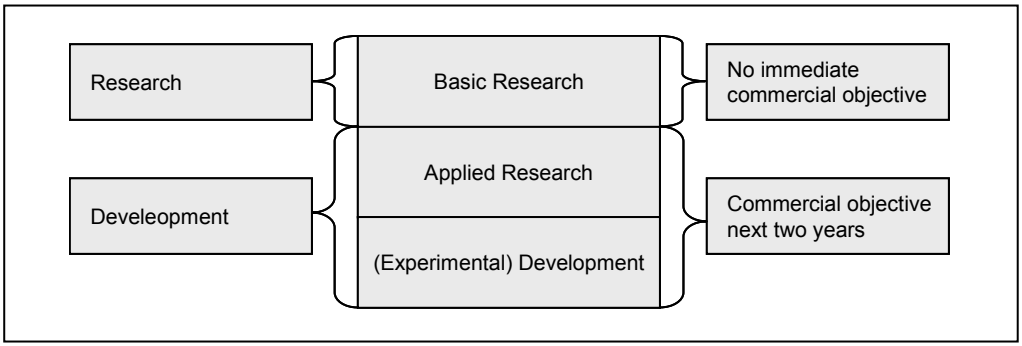


Figure 1: The Composition and Time Horizon of R&D Activities

To categorize international R&D activities, Zedtwitz and Gassmann (2002) suggest distinguishing between research, which involves applied sciences, and development, which involves engineering. Other categorizations are more granular and reflect different purposes and patterns of collaboration of technical work. Medcof (1997) distinguishes between "research", "development", "marketing support", and "manufacturing support". Research describes the discovery of new scientific knowledge that has the potential to serve as platform for the subsequent development of products or processes. This work is performed without collaboration between the technology unit and the firm's marketing or manufacturing function. Development encompasses the creation of new products ("product development") and processes ("process development") that have commercial value and is characterized by collaboration with marketing and manufacturing units respectively. Marketing support describes the adoption of already established product technology to specific customer needs or the provision of technical customer support. These activities are performed with collaboration between technology and marketing, but without involvement of the manufacturing function. Manufacturing support, finally, adapts already established process technology to particular conditions. This type of work requires collaboration between the technology

and manufacturing functions without significant contribution of marketing.

Taking a subsidiary perspective, Hegde and Hicks (2008) divide innovative capability of subsidiaries into three categories, with decreasing sophistication: use-inspired basic research, multi-technology product innovation, and incremental innovation. Other studies consider different technological functions that were assigned to the foreign affiliate: namely, adaptive or incremental R&D; innovative R&D for local, regional, or global markets; and technology monitoring, which has a listening post function to detect and observe technological developments in the host country (Almeida 1996; Florida 1997; Frost 2001). Adaptive R&D again may comprise a variety of tasks ranging from basic production support to the adaptation and upgrading of imported technologies. (For a more detailed description of these three roles, see UNCTAD 2007, pp.138 et seq.) With regard to the relative importance of different roles, Singh (2007) finds that, despite the growing number of MNE subsidiaries performing advanced research, the majority of subsidiaries have a mandate either for incremental adaptation of the parent firm's products for local markets, "just as it was reported years ago in surveys such as Mansfield et al. 1979" (p.767), or as a listening post for technology monitoring.

This study considers R&D on the basis of subsidiaries' formal R&D function. Informal or occasional R&D avtivities in other functions is not included. Although the differentiation between research and development – or further subdivision – is valuable for some research purposes, it seems appropriate to apply the formal business function as international configuration aspects (location and cross-boarder integration) are analyzed. Also worth considering is that basic research activities represent only a marginal part of overall, and particularly foreign, business R&D (Frost, Birkinshaw, and Ensign 2002; Kuemmerle 1999a) – a fortiori in emerging economies (UNCTAD 2005). Moreover, this scope considers the evidence of Van Ark et al. (2008), who assert that "the boundary between applied research and development is not precise and it is not clear whether different firms draw the line between these two activities in the same way, when responding to […] statistical surveys" (p.18).

2.1.2 Configuration of R&D Activities

International business strategy comprises two major elements: the configuration of a firm's value creation activities and the coordination of these activities (Sullivan and Bauerschmidt 1991). Configuration describes the geographical location of a firm's value creation activities, as well as the cross-boarder resource interdependencies, while coordination refers to the extent that like activities are performed in the same way (Porter 1986a, 1986b), with mechanisms ensuring an efficient flow of information and knowledge across boarders (Bartlett and Ghoshal 1989). The configuration of value activities has gained increasing research attention (e.g., Adler and Hashai 2007; Craig and Susan 2000; Fine et al. 2002; Roth 1992; Taggart 1998a) and represents an established approach in international strategy research (Birkinshaw and Morrison 1995). For a recent overview of literature on international configuration and coordination see, e.g., Holtbrügge (2005).

The basic consideration of configuration is an international division of labor and specialization on certain activities. Foreign subsidiaries are no longer regarded as isolated units in their respective host market but as part of the MNE's global network (Porter 1986a). The concept of a subsidiary strategy goes back to the seminal work in global strategy by Bartlett (1979) and Prahalad and Doz (1981), which emphasized the conflicting need for local responsiveness and global integration. Bartlett and Ghoshal (1989) worked on the premise that each subsidiary has a specific role to play in the MNE's global network, modeling subsidiary strategy as a function of the local environment and the subsidiary's unique capabilities (Birkinshaw and Morrison 1995).

The international configuration of firms' R&D activities represents the main focus of this study. Configuration includes, on the one hand, the geographical location of R&D activities and, on the other hand, the cross-border flows of added-value between subsidiaries (horizontal) and between headquarters and subsidiaries (vertical). In this study, these international interdependencies between the respective subsidiary and other units of the MNE network are also referred to as cross-border integration or, in

shortform, “integration“. In global strategy literature, the terms “subsidiary strategy” and “subsidiary role” are often applied interchangeably (Birkinshaw and Morrison 199. The same holds for literature on international R&D, which frequently uses them synonymously. Other terms, like subsidiary “mandate” and ”mission“, or “type of R&D” can also be found in this context. Birkinshaw and Morris (1995) argue that despite the interchangeable use in literature, there is more than a semantic distinction between the terminologies: “Role suggests a deterministic process whereby the subsidiary fulfils its 'imposed' function” while strategy “suggests a higher degree of freedom on the part of subsidiary management to define its own destiny” (p.733). Manolopoulos, Papanastassiou, and Pearce (2005) argue in the same direction when stating that “[t]oday, rather than accepting predetermined roles, subsidiaries are asked to actively engage in developing their operations and [to] explore procedures that would increase the efficacy of the whole MNE network” (p. 250). In the literature review, publications applying the different terminologies were considered. In this study, the term “strategy” is preferred to emphasize the autonomous initiative of the individual subsidiary with regard to its innovation activities (seeGupta and Govindarajan 1994, p.443). “Strategy” thereby refers to the “configuration” of value creation activities. Accordingly, “R&D strategy” and “international configuration of R&D”, or the shortform “R&D configuration”, are considered synonymous. The same holds for the different denotations that can be found in literature to describe R&D activities outside an MNE’s home country, such as “foreign“, ”international“, and ”overseas” R&D.

2.1.3 Emerging Economies

Despite the increasing research attention, there is no generally accepted set of criteria and no commonly applied definition of emerging economies (Peng 2000). The variety of labels that have been applied to describe these countries includes less-developed countries, low-wage countries, newly industrialized countries, and low-cost countries. Whereas some terms express the availability of cheap resources (Arnold and Quelch 1998), particularly international marketing literature applies the term

emerging market (EM), indicating a focus on the countries' increasing sales potential. Accordingly, the "plethora of country classification schemes" has been inconsistently used in research and practice (Burgess and Steenkamp 2006, p.336).

Emerging economies usually show some common characteristics. These include: 1) a low level of absolute economic development, 2) rapid economic growth rates, with a switch from the agricultural to the industrial sector and decreasing poverty, and 3) a rising free market system with increasing free trade and growing market capitalization of publicly traded companies (see Arnold and Quelch 1998; Burgess and Steenkamp 2006). Because of a relatively stable and responsible macroeconomic policy, these countries were able to create a physical and institutional environment including legislation, regulation, as well as infrastructure (see Lenartowicz and Johnson 2007; Peng 2003; Peng, Wang, and Jiang 2008) that encourages business activities (Khanna and Palepu 1997).

The World Bank applies a classification of countries with four categories, based on the absolute level of economic development (see World Bank 2008). It is measured in terms of gross national income (GNI) per capita by country, adjusted for currency fluctuations. Countries with a GNI of US$ 935 or less are regarded as low income, of US$ 936 to US$ 3,705 as lower middle income, of US$ 3,706 to US$11,455 as upper middle income, and of US$ 11,456 and more as high income. Low-income and middle-income economies are sometimes referred to as developing economies.

The United Nations (UN) classifies countries based on their score on the human development index (HDI). The HDI represents a normalized qualitative indicator of countries' achievements and comprises the following three dimensions: gross domestic product (GDP) per capita at purchasing power parity (PPP), life expectancy at birth, and adult literacy rate. Countries with low or medium human development are usually considered emerging countries; countries with high HDI values are considered as developed countries.

The International Monetary Fund (IMF) in its World Economic Outlook distinguishes between advanced economies on the one hand and emerging and developing economies on the other. The classification is not based on strict criteria; instead, the classification "has evolved over time with the objective of facilitating analysis by providing a reasonably meaningful organization of data" (IMF 2008, p.252). The group of advanced economies is divided into subgroups, namely major advanced economies, which is often referred to as the Group of Seven (G7); the members of the euro area; and newly industrialized Asian economies, including Singapore and Korea. The group of emerging and developing economies of the IMF comprises all countries that are not considered advanced economies. Subgroups are formed along regional breakdowns, as well as on the basis of analytical criteria, including countries' composition of export earnings, exchange rate arrangements, and financial criteria based on external financing sources and experience with debt servicing.

The World Trade Organization (WTO) distinguishes between developed and developing countries. However, a definition of the classifications does not exist; they are instead based on the countries' self-selection. About two-thirds of the WTO member countries classify themselves as developing countries; half of these are designated as least-developed countries.

For the study at hand, emerging economies are distinct from developing countries on the one hand and developed (alternatively: industrialized) countries on the other hand. Emerging economies are more advanced than developing countries but have not yet reached the standards of the developed countries with regard to the characteristics already described. The research focuses on the major emerging countries that play an increasing role in the world economy. These are Brazil, Russia, India, and China (the so-called "BRIC countries"), as well as the emerging economies of the Association of Southeast Asian Nations (ASEAN). The terms "emerging economies", "emerging countries", and "emerging markets" are thereby used synonymously.

Figure 2 (based on Burgess and Steenkamp 2006) visualizes the popular country

classifications proposed by the WTO and UN with their respective GDP per capita range as well as the GDP per capita range of the emerging economies investigated in the present study.

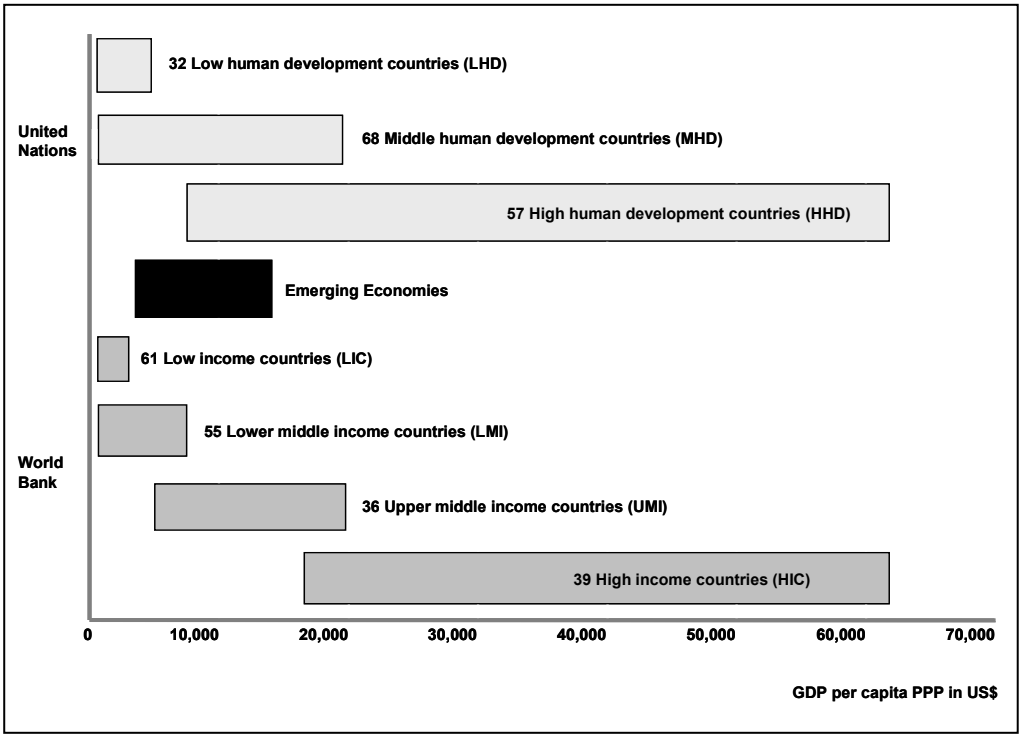


Figure 2: Alternative Country Classifications and GDP per Capita Range

2.1.4 Subsidiary

Subsidiary describes an organizational entity that is controlled by another entity, referred to as the parent company. Control is usually achieved by ownership shares of the parent company in the subsidiary. A wholly owned subsidiary is a subsidiary where the ownership is not shared but the subsidiary belongs fully to the parent com-

pany. The parent company with all its subsidiaries forms a group. When the members of this group are located in two or more different countries (see Caves 1996), they constitute an MNE. The entities within an MNE are assumed to be linked in a way that they may coordinate their operations in various ways (OECD 2008b). Alternative notations to MNE that can be found in the literature are multinational corporation (MNC) and transnational corporation (TNC) (see Pitelis and Sugden 2000).

In this study, the terms subsidiary and affiliate are used synonymously. Because the reserach focuses on subsidiaries' R&D activities in the respective host countries, the terms "R&D unit", "R&D site", and "R&D laboratory" (or lab), all established in the literature, are used as synonyms as well.

2.2 Review of Existing Literature

This section provides an overview of the existing literature related to the research topic of this study. A literature review represents a systematic analysis of existing contributions comprising the identification, evaluation, and interpretation of documents related to the research topic (Fink 2005; Hart 1998). It has to demonstrate that "all the main concepts, theories, theorists and methodological approaches relevant to the topic have been identified, understood, and critically evaluated" (Hart 1998, p.172). In the following section, the procedure and the selection criteria applied for the literature review are introduced before the results are then discussed in the following section.

2.2.1 Selection Criteria and Procedure for the Literature Review

Research on international R&D comprises a multitude of different topics (see Cheng and Bolon 1993). This diversity requires the definition of clear selection criteria prior to the review. Publications addressing aspects of international R&D strategies, such as R&D configuration, typologies of international R&D activities, R&D site selection,

and subsidiary roles, were considered. Also included were publications on R&D-related cross-boarder technology and knowledge flows. Not considered were publications dealing with international innovation processes and human resources (HR) management in multinational R&D (e.g., the management of internationally dispersed R&D teams). The same applies for publications focusing solely on the ownership dimension of international R&D (e.g., R&D collaboration).

To identify relevant contributions, the leading journals were reviewed systematically. The identification was based on the selection of Werner (2002) and the journal ranking by the German Academic Association for Business Research (see Henning-Thurau, Walsh, and Schrader 2003). Moreover, a keyword search was conducted in two leading electronic bibliographic databases for scholars: EBSCO/EPNET and AIB/Inform Global. For this search, a long list of keywords was developed comprising multiple variations and combinations of terms related to international R&D strategies. Furthermore, a complementary manual search (of the Internet and the Online Public Access Catalogue (OPAC) at WHU – Otto Beisheim School of Management) was conducted to identify any additional relevant publications.

The literature review primarily focused on peer-reviewed studies (see Cooper 1998) with empirical results in English-speaking journals. Purely conceptual publications, as well as books, book chapters, and publications by public organizations, were included when the work gained considerable research attention in the field. These sources were mainly identified by cross-references.

The following journals turned out to be the most important ones for the topic under investigation: Journal of International Business Studies, Strategic Management Journal, Research Policy, Management International Review, R&D Management, and International Business Review.

2.2.2 Overview of Existing Literature

Some of the most important decisions by MNEs involve the location of specific activities of the value chain. In contrast to other functions (e.g., manufacturing), relatively little research has been done on factors influencing a company's choices regarding the location of R&D activities (Feinberg and Gupta 2004). Yet in the past two decades, research on internationalization of R&D has gained momentum, and the increasing body of literature in this field has advanced our understanding of this phenomenon. For comprehensive overviews on internationalization of R&D and innovation activities, readers may turn to Brockhoff (1998) and, more recently, Narula and Zanfei (2005). This section provides an overview of the most notable contributions in a strongly fragmented research field (see Ambos and Schlegelmilch 2004) and thus helps to understand the positioning and research contribution of this thesis. This section describes and discusses existing literature from three perspectives: The first subsection outlines the development of the research field with regard to the research focus, topics, trends, and applied methodology. The second subsection provides an overview of investigated motives and drivers of international R&D activities discussed in literature. Finally, the third subsection reviews existing taxonomies and classifications of foreign R&D units.

Research Focus and Methodology

Until the 1980s, the internationalization of R&D was of very little research interest, either to economic and business theorists, or to statistical agencies or government institutions in developed countries (Niosi 1999, p.107). Research in the field of international R&D mainly began with the pioneering studies by Ronstadt (1978), Hewitt (Hewitt 1980), and Behrman and Fischer (Behrman and Fischer 1980a, 1980b). Nevertheless, in the 1980s and beginning of the 1990s, the topic still did not receive much attention. Since the mid-1990s, however, the academic field of R&D management has gained in importance considerably (see Brockhoff 1999). In more recent years, international aspects of R&D management have increasingly received attention from researchers; studies in this field have gained momentum, reflected in the increasing

numbers of publications addressing it.

In their article, ”The Management of Multinational R&D: A Neglected Topic in International Business Research“, published in the Journal of International Business Studies (JIBS), Cheng and Bolon (1993) group research literature on the management of multinational R&D in five categories: 1) Site selection for foreign R&D subsidiaries, 2) local autonomy granted to subsidiaries, 3) international coordination of multinational R&D, 4) organizational structure for foreign R&D activities, and 5) human resource management in multinational R&D; they conclude that “despite the growing involvement of multinational firms in foreign-based R&D during the past 15 years, little research has been done on why and how firms internationalize their R&D and what effects it might have on firm competitiveness” (Cheng and Bolon 1993, p.1). Recently, Hegde and Hicks (2008) divided research on international R&D into three periods based on the perspective of the time: The first theories of globalization, until about 1980, assume that R&D followed manufacturing to adapt products and processes to local markets. As a next evolutionary step, scholars then added the listening post functions to account for the increase of overseas R&D. In both the adaptation/modification and the listening post models, foreign R&D sites were considered auxiliary outposts supporting the R&D in the home country. Since the 1990s, subsidiaries have also been regarded as a source of innovation: New knowledge is created and transferred to the company’s central R&D.

To investigate the internationalization of R&D, researchers have applied a multitude of research methods. Case study and small sample studies (e.g., Beckmann and Fischer 1994; Cantwell 1989; Chiesa 1996a; Florida 1997; Gassmann and Han 2004; Hakanson and Nobel 1993a, 1993b; Kenney and Florida 1994; Mansfield, Teece, and Romeo 1979; Serapio Jr and Dalton 1999; Wortmann 1990; Zedtwitz 2005; Zedtwitz and Gassmann 2002) mainly focus on processes and different motives of FDI in R&D. These studies generally examine R&D internationalization from one home country in one host country.

Other studies use aggregated data (e.g., Beise and Belitz 1998; Belderbos 2003; Fors and Zejan 1996; Hirschey and Caves 1981; Kumar 2001) or apply patent analysis (e.g., Belderbos 2001; Cantwell and Janne 1999; Criscuolo, Narula, and Verspagen 2002; Le Bas and Sierra 2002; Niosi 1997; Patel and Pavitt 1991; Patel and Vega 1999; Reger, Beise, and Belitz 1999) or a combination of both methods (e.g., Dunning and Narula 1995; Hegde and Hicks 2008; Iwasa and Odagiri 2004). Although studies that build on aggregated or government data are able to quantify FDI, they do not incorporate firm level factors. In terms of data, patent output is used as an indicator of innovation and R&D success (Almeida 1996; Le Bas and Sierra 2002). For instance, Cantwell (1995)investigated the extent of invention outside companies' home country and showed that the largest U.S. and European companies have generated an increasing share of their patentable innovations outside their home country. Patent analysis might also allow firm level studies. A review of the citation patterns of patents (Almeida 1996) revealed not only intra-regional effects of but also could identify specific firm-to-firm linkages. On this micro-level, however, this method also shows severe disadvantages with regard to inter-company comparability and availability of patent data (see, e.g., Ambos 2005; for a critical evaluation see also Chapter 5.1.1).

Survey-based studies focus mainly on different structural aspects of foreign R&D. Similar to case study research, most large-scale analyses focus on the extent and funding modalities of foreign R&D in specific countries (e.g., Hakanson and Nobel 1993b; Hirschey and Caves 1981; Howells 1990a; Mansfield, Teece, and Romeo 1979; Pearce 1989). The investigations predominantly cover R&D activities in triad countries, notably the United States, Great Britain, Sweden, and Japan. More recently, there has been a tendency in survey-based studies to aggregate data on multiple countries, assuming that there are no differences between the countries (Edler, Meyer-Krahmer, and Reger 2002; Gassmann and Zedtwitz 1999; Kuemmerle 1997, 1998, 1999a, 1999b; Papanastassiou and Pearce 2005; Patel and Vega 1999; Zedtwitz, Gassmann, and Boutellier 2004). Although internationalization processes may be similar across host countries, there is evidence that considerable differences

exist between companies from different home countries, even within Europe. Ambos (2005), for example, investigated the internationalization process and the underlying motivations and missions of German companies, In his study, he comes to the conclusion that "[c]uriously, in many instances German firms appear to mirror Japanese rather than, for example, Swedish or British MNEs. Compared to Sweden and Britain, both Japan and Germany may be considered late movers when it comes to the timing of internationalization" (p.406).

Motives and Drivers of International R&D

Determinants for internationalizing R&D have been investigated in a growing body of academic literature. Accordingly, extant research suggests a variety of motives (see Brockhoff 1998 for a comprehensive review). The bulk of extant studies has thereby studied the determinants of foreign R&D location in an inter-industry or inter-firm context (Kumar 2001). Some authors identify more than 20 different motives. Hakanson and Nobel (1993a; 1993b), for example, analyzed the R&D internationalization motives of Sweden's 20 largest MNEs and found 21 motives that by cluster analysis were assigned to 5 different categories. The authors conclude that different types of foreign R&D activities are driven by different motives. On the basis of case study research, Zedtwitz, Gassmann, and Boutellier (2004) investigate more recently occurring drivers and challenges of global R&D. They identify six dilemmas that make it difficult for companies to exploit the full potential of an internationalized structure of this business function. The authors conclude that there is no single best solution to reap the benefits that the internationalization of R&D offers and to overcome the barriers. Rather, there has to be a fit between these drivers and the specific type of R&D unit.

Traditionally, market size is found to be one of the most important motivations for FDI in R&D (e.g., Archibugi and Iammarino 2002; Kumar 1996; Love 2003; Love and Lage-Hidalgo 2000). Proximity to foreign markets allows MNEs to exploit company-specific capabilities more widely. A considerable part of the existing literature suggests that a high level of local R&D is carried out primarily to adapt products to local

market requirements (Hakanson and Nobel 1993b; Howells 1990a). Because local demand grows increasingly sophisticated, local R&D capabilities are used to adapt existing products to local needs. Moreover, R&D units may support local sales activities and manufacturing operations and improve responsiveness in terms of both speed and relevance (Gammeltoft 2006). Lewin, Massini, and Peeters (2009) argue that "[a]s firms establish manufacturing facilities abroad and assign increasingly complex products to them, locating R&D sites in close proximity to factories becomes a requisite feature" (p.904).

Florida (1997) investigates the motives of foreign-owned R&D laboratories in the United States and concluded that the main drivers are technology-oriented rather than market-oriented. The three most important motives identified were "developing new product ideas", "obtaining information on U.S. scientific and technical developments", and "gaining access to scientific and technical talent". The market-oriented motives, "customize products for local U.S. market" and "work with local manufacturing facility", were ranked fourth and sixth, respectively. Gerybadze and Reger (1999) also emphasize the motive of acquiring impulses for innovation by having a presence in a highly innovative environment (i.e., the motive of learning in lead markets).

Hegde and Hicks (2008) analyze the relation of international R&D activities of subsidiaries from U.S. MNE and host-country characteristics. For their industry-level analysis, the authors used multiple secondary data sources and showed that foreign country market size, the host country's scientific capabilities, and the technological strength of the industry determine both the probability and extent of R&D and patenting activities. Although market size is found to primarily drive the location of foreign R&D, the science and engineering capabilities of the host country were found to positively influence the intensity of foreign subsidiaries' R&D activities. This result indicates a change from market- to resource aspects for foreign innovation activities.

Several studies analyzed whether firms internationalize R&D to benefit from home country strengths or to compensate for weaknesses in the home country. The litera-

ture shows ambiguous results. While some studies argue that companies internationalize their R&D to complement the strengths of the home country (Florida 1997; Papanastassiou and Pearce 1998; Serapio Jr and Dalton 1999), other studies show that companies invest in foreign R&D to compensate for weaknesses in the domestic stock of knowledge in the home country (Le Bas and Sierra 2002; Patel and Vega 1999). These mixed results regarding the motivation might be ascriped to different home countries (Lam 2003; Le Bas and Sierra 2002). Numerous contributions distinguish between drivers favoring centralization – in other words, "centripetal forces" – and drivers favoring decentralization – so-called "centrifugal forces" – in international R&D configuration (Granstrand, Hakanson, and Sjölander 1992; Hirschey and Caves 1981; Pearce 1989). Strong centrifugal forces are usually local responsiveness and adaptation speed of existing products or processes to local market requirements or access to critical resources, as well as political or regulatory factors. Economies of scale, on the other hand, represent a driver favoring centralization. Early literature even suggests decentralization only when the central R&D function in the home country exhausts its resources like personnel or equipment (Pearce 1989). Other factors driving centralization are difficulties in communication, governance and control issues, and security concerns (e.g., violation of intellectual property rights (IPR) abroad). Kumar (2001) finds in his analysis of government data from the United States and Japan that availability and cost of of labor, innovative activity in the host country, policy factors, IPR protection, and openness of the trade regime influence a company's decision regarding the location of R&D activities.

Economies of geographical agglomeration or clusters are also considered drivers of R&D location. MNEs often seek to establish R&D activities close to local clusters of excellence, which consist of "groups of dynamic, interrelated firms and specialised scientific institutions that attract like-minded, technologically advanced competitors and potential business partners" (Davis and Meyer 2004, p.361). Cutting-edge know-how for particular trendsetting technologies is often concentrated in such geographically limited centers – so-called "pockets of innovation" (see Gerpott 1991, pp.54 et seq.). Companies want to be in these locations to keep up with the latest technologi-

cal developments. Research on national innovation systems (Lundvall 1988; Nelson 1993) has shown how specific nations and regions may emerge as especially advantageous for innovation. Geographical agglomeration and clusters have traditionally been considered as motive for R&D centralization. However, with increasingly specialized knowledge bases all over the world, these motives are increasingly considered as factors driving internationalization of R&D rather than centralization of innovation activities. Cantwell (1995) thus concludes that local economies of integration and agglomeration have become more important than central economies of scale in R&D.

Cantwell and Mudambi (2000) investigated the role of host government incentives for foreign R&D investments and found a positive effect of local infrastructure on the scope of foreign subsidiaries' R&D mandate. They were able to show that particular tax credits have an important incremental effect on the location of R&D and encourage subsidiaries to expand their technological role in the corporate R&D network. These findings are consistent with the results of an econometric study by Hall and Reenen (2000), who showed that in OECD countries firms increase their R&D in response to tax credits. However, Cantwell and Mudambi (2005) argue that government investment incentives are insufficient to attract high quality R&D investment by MNEs and found empirical evidence that such incentives may even exert a negative influence on the subsidiary's R&D intensity.

Gassmann and Zedtwitz (1998) build on the work of Beckmann and Fischer (1994) (1994), De Meyer and Mizushima (1989), Hakanson and Zander (1988), Krubasik and Schrader (1990), Boehmer et al. (1992), and Coombs and Richards (1993); they classify R&D internationalization drivers into the following five categories: input-oriented, output-oriented, external, efficiency-oriented, and political/social-cultural. In addition, they research determinants that act against international R&D, which they divide into two categories: those that explicitly prevent R&D internationalization and those that favor centralization of R&D (see Gassmann and Zedtwitz 1998, pp.151 et seq.). Gassman and Han (2004) take up the described classification of R&D internationalization drivers and investigate motivations and barriers of foreign R&D activities

in China. Based on case study research, they identify three country-specific categories of drivers: input-oriented motivations, performance-oriented motivations, and business-ecological motivations. Furthermore, they distinguish between three types of barriers for managing R&D in China: barriers at the intra-organizational level (e.g., cultural distance, language difficulties, different mindset), barriers at the inter-organizational level (e.g., bureaucracy, uncertain legal environment), and uncertainty in fairness of R&D cooperations (e.g., intellectual property rights).

In sum, a great variety of motives for the internationalization of R&D has been identified. In particular, more recent literature therefore classifies these factors into a dichotomous set of motives (Kuemmerle 1999a) with a distinction between demand-side factors on the one hand and supply-side factors on the other hand. Alternative terminologies for these categories are “home-base augmenting” vs. ”home-base exploiting” sites, ”market-seeking’ vs. ”resource-seeking” motives, or ”technology-exploiting’ vs. ”technology-seeking” motives for international R&D.

Demand-side factors cover customizing motives (Florida 1997; Gaussens, Lecostey, and Shahbazi 2004) resulting from pressure from the local subsidiary, political pressure, or market requirements (Niosi and Godin 1999). A considerable part of the published literature by the 1980s and mid-1990s argued that FDI occurs when firms aim to exploit firm-specific capabilities or assets in foreign countries (Dunning and Lundan 2009). Theories based on Vernon’s (1966) international product life cycle (IPLC) hypothesis suggest that R&D follows manufacturing to adapt products and processes to local markets (Hegde and Hicks 2008). Gammeltoft (2006) describes these theories as the "traditional view” of international R&D. Several studies have described the importance of FDI in R&D for exploiting firm-specific advantages in foreign environments by adapting existing products and technologies to differing local customer needs or providing technical support to offshore manufacturing plants (e.g., Bartlett and Ghoshal 1990; Hakanson and Zander 1988; Hirschey and Caves 1981; Mansfield, Teece, and Romeo 1979; Pearce 1989). Researchers argue that with growing local demand and increased customer sophistication, R&D sites in close proximity to

manufacturing facilities abroad are necessary to support the knowledge transfer from the company's home location to actual local manufacturing. According to Kuemmerle (1999a) and Lewin, Massini, and Peeters (2009), the importance of locating the R&D function with the manufacturing operations and local demand has not only been described in international business literature but also in industrial geography (Fors 1997; Howells 1990a, 1990b) and technology management (Clark and Fujimoto 1991; Hayes and Wheelwright 1988; Hippel 1988; Nonaka and Takeuchi 1995). In addition, other authors emphasize the importance of geographic proximity and cooperation between local R&D and other functions of a foreign subsidiary, particularly marketing (Florida 1997), to gain access to local markets and customers (Zedtwitz and Gassmann 2002).

As a next step, scholars then added the "listening post" functions to account for the increase of overseas R&D during the 1990s (see Hegde and Hicks 2008). Dunning (1994, pp.75 et seq.) described the related activities of foreign R&D units as research to acquire or gain an insight into foreign innovation activities (i.e., learning and building firm research capability). Patel and Vega (1999) emphasize the necessity of "listening posts" in centers of excellence so that companies can scan and monitor technological developments and innovations. Dunning and Lundan (2009, p.15) refer to Cantwell and Piscitello (2000) and argue that this phase marked a shift in the technological paradigm in that, "as the potential of existing technologies to exploit scale and scope economies began to be exhausted, […] asset-seeking investment had not yet taken off". In both the adaptation/modification and the listening post models, however, foreign R&D sites were regarded as auxiliary outposts supporting the R&D in the home country.

Finally, subsidiaries were also regarded as sources of innovation: new knowledge is created abroad and might be transferred to the company's central R&D (see Dunning and Lundan 2009; Hegde and Hicks 2008). Thus, internationalization of R&D is not only "pushed" by the firm-specific advantages of the MNE but might also be "pulled" toward foreign centers of innovation to acquire and develop new capabilities (Le Bass

and Sierra 2002, p.590). The underlying location-specific supply-side factors hence represent resource-seeking motives for the augmentation of the company's knowledge base. Countries differ in their technological advantage (Kogut 1990) and in the character and size of the respective national innovation systems (Krugman 1991; Nelson 1993; Pearce 2004; Porter 1990; Scherer 1992) and thus also in their attractiveness for R&D activities (Kuemmerle 1999a). The availability of superior or cheaper resources and the proximity to foreign universities and other knowledge-creating institutions is a main motivational aspect on the supply side (Florida 1997). When locating their R&D unit close to a cluster of scientific excellence, companies can tap into new knowledge sources (Kuemmerle 1999a), gain access to leading scientific and technological know-how, or recruit high-quality researchers (Odagiri and Yasuda 1996). Through interactions with the local knowledge pools, foreign R&D units can contribute to the company-wide innovation network by taking advantage of the local technological environment (Iwasa and Odagiri 2004). Feinberg and Gupta (2004) found that external knowledge spillover opportunities from competitors, as well as internal firm-specific capabilities for knowledge use are important drivers of R&D location decisions of MNEs.

Table 1 (based on Hegde and Hicks 2008) summarizes the evolution of foreign subsidiary R&D activities over the past half century, illustrating the different subsidiary functions and respective macro-level and host country drivers.

All these studies show that there are numerous reasons for companies to internationalize their R&D activities. Foreign R&D units today often have broader missions than the traditional ones that supported local sales activities through the adaptation of products or processes to local demands. Correspondingly, changes in global markets and in competition, technology, and policy environments have also widened the variety of possible motives for international R&D. Song and Shin (2008) note that "[r]ecently, both the extent to which MNCs perform R&D outside their home countries and the types of foreign R&D have changed considerably" (p.292). In literature, however, there is no strong consensus on the classification of different motives. For some

motives, there are contradicting results with regard to the direction of effect (centralization vs. decentralization).

Timeline	Subsidiary R&D Function	Facilitating Factors	Foreign Country Drivers
<1980	Market customization	Learning to operate abroad	Consumer demand
1980-1990	Listening post activities	Decreased communication costs	Industrial and technological strength
>1990	Sources of innovation - Incremental innovation - Multi-product innovation - Frontier innovation	Increased variety in means of communication Proximity to manufacturing and to industrial customers	Science & technology human capital

Table 1: The Evolution of International R&D

Taxonomies of Foreign R&D Units

In 1993 Cheng and Bolon noted that "past research has paid little attention to the different types of foreign R&D performed by multinationals and how these might affect the internationalization decisions and their subsequent implementations" (Cheng and Bolon 1993, p.13). Although a multitude of schemes to classify different types of international R&D units have been proposed in literature since the late 1990s, there is as yet no strong consensus on a standardized classification. Ambos (2005) even states that the diversity "indeed leads to some confusion on how to classify investments" (p.402). For an extensive review of existing classifications, see Medcof (1997) and Niosi (1999). An overview can also be found in the World Development Report on internationalization of R&D (UNCTAD 2005, pp.138 et seq.). In the following, the typologies that are considered most influential are introduced.

In his pioneering study in the field of international R&D, Ronstadt (1978) suggests the first evolutionary pattern in R&D internationalization based on the IPLC model (see Niosi 1999, p.109). He identifies four types of R&D units based on their primary pur-

pose at the time they were created abroad by the organization: 1) The Transfer Technology Unit (TTU) is established to support a foreign subsidiary in its transfer of manufacturing technology from the home country while also providing related technical services for foreign customers; 2) the Indigenous Technology Unit (ITU) is established to develop newly improved products, especially for foreign markets but without necessarily drawing on parent technology; 3) the Global Technology Unit (GTU) is established to develop new products and processes for simultaneous or new simultaneous application in major world markets of the MNE; and 4) the Corporate Technology Unit (CTU) is established to work using a longer term perspective or in an exploratory nature for the parent company. TTUs and ITUs both serve local customers, but while TTUs only provide technical services for products that were developed in the home country, ITUs also develop differentiated products to serve the special needs of the local market. CTUs are integrated into the global corporate value creation network. They can be located along with other functions (e.g., manufacturing) of an affiliate with a global product mandate; can serve as a stand-alone R&D laboratory, working on projects as part of the decentralized corporate R&D network; or can generate new knowledge exclusively for the parent company and thus contribute to the firm's competitiveness.

Bartlett and Goshal (1990) distinguish between four different organizational models for international innovation projects: 1) "Center-for-center", in which new products or processes are developed in the home country for the global market; 2) "local-for-local" units, which develop products or processes locally in the host country for use in the local market only; 3) "locally leveraged" foreign R&D units, which develop products or processes in the host country for global use; and 4) "globally linked" R&D units, which are integrated into the global corporate R&D network and develop technologies through collaboration with other geographically dispersed R&D units for use in the world market.

In their frequently cited studies, Hakanson and Nobel (1993a; 1993b) analyzed foreign R&D investments made by Swedish companies and classified laboratories on

the basis of the motives to maintain foreign R&D units and the historical processes that originally led companies to perform R&D outside their home country (see Chapter 2.1). They defined five categories: market oriented, politically motivated, production support, research, and "multi-motive", for those units n which no single dominant motive could be identified. This last group accounted for more than one-third of the observed technology units.

Chiesa (1996a) bases his classification to a substantial degree on Ronstadt's arguments and distinguishes between two types of foreign R&D units: support laboratories, for current products and processes, and exploitation laboratories. According to this classification, support laboratories are established with the aim of extending the company's knowledge base in the short term. Exploitation laboratories explore new technologies with a long-term perspective. For each laboratory type, Chiesa defined subcategories based on the degree of dispersion of external technological knowledge.

Kuemmerle (1997; 1999a; 1999b) differentiates between two types of R&D units, depending on the laboratory mission: home-base exploiting (HBE) or home-base augmenting (HBA). He builds his taxonomy on a dichotomous set of motives: the distinction between demand-side factors and supply-side factors as the main mission of the foreign R&D unit (see previous section on motives and drivers). HBE R&D investments are primarily connected to the local marketing and manufacturing function, supporting the local operations with product and process adaptations to local market needs. With investments in HBA R&D units, in contrast, companies seek to access unique resources and inputs and to capture "augmenting" externalities resulting from local institutions and firms. Because of the simplicity in its dichotomous categorization, the taxonomy of Kuemmerle is frequently cited and serves as basis for numerous subsequent studies (e.g., Ambos 2005; Belderbos 2001; Belderbos, Lykogianni, and Veugelers 2003, 2004; Cantwell and Mudambi 2005; Criscuolo, Narula, and Verspagen 2002; Lewin, Massini, and Peeters 2009; Patel and Vega 1999), although such studies at times make use of different labels, such as "capability exploiting" vs.

"capability augmenting" subsidiary, "technology exploitation" vs. "technology sourcing", or "asset exploiting" vs. "asset augmenting" R&D. For instance, in their article published in the *Strategic Management Journal*, Cantwell and Mudambi (2005) build on the dichotomy of subsidiary types introduced by Kuemmerle and investigate the process of subsidiary evolution. Their work examines how the distinction between competence augmenting and competence exploiting in organizational learning affects the level of R&D in each type of subsidiary. The authors find that whether a subsidiary achieves a competence-creating output mandate or a purely competence-exploiting mandate depends on MNE group-level and subsidiary-level characteristics, as well as location factors. Ambos (2005) investigates international R&D investments of German multinational companies. On the basis of a survey conducted at the headquarters of 49 German companies, he examined the level and pace of internationalization of R&D activities; the motivations and mandates of overseas R&D sites; and the ties between R&D laboratories, the corporate headquarters, and the local environment. In applying Kuemmerle's dichotomous categorization of R&D units – labeled "capability-exploiting" and "capability-augmenting" – he observes, in line with prior studies, a shift away from market-seeking investments and toward resource-seeking investments.

The limitation to only two types of foreign R&D presents a holistic classification of foreign R&D units. Despite its frequent adaptation, it is doubtful that this concept can serve as a standard for the categorization of international R&D. Le Bass and Sierra (2002) find that the distinction between the two types of foreign R&D might "not be as clear-cut as presented" (p.591). Moreover, the dichotomous set of motives only implicitly accounts for different functions and laboratory specializations, whereas other types of international R&D units are not covered at all (Brockhoff 1998, p.57). Moreover, the concept is rather static and does not account for gradual differences and respective developments over time.

Zedtwitz and Gassmann (2002) distinguished between research, which involves applied sciences, and development, which involves engineering. While scientists aspire to find new phenomena and create new knowledge, engineers develop new technol-

ogy and products, using primarily existing knowledge in a novel way. In a broader sense, this categorization corresponds to the distinction between home-base augmenting and home-base exploiting laboratories. Both activities can be either performed domestically or internationally dispersed. Based on these two dimensions, they deduce four archetypes of R&D internationalization: national treasure R&D (domestic research and domestic development), technology-driven R&D (dispersed research and domestic development), market-driven R&D (domestic research and dispersed development), and global R&D (dispersed research, dispersed development). In their survey-based study, the authors find that the location drivers for research are different from those of development. While international research is mainly driven by science and technology drivers, internationalization of engineering is mainly market driven. These findings confirm the results of Kuemmerle (1999a) and his dichotomous set of motives of FDI in R&D.

Papanastassiou and Pearce (2005) analyzed the funding sources of 48 R&D units of foreign MNEs in the United Kingdom. They relate five separate funding sources (associated local producing subsidiary, parent company, other affiliates from the corporate group, UK government funds, and EU funds) to four different categories of R&D units. The Support Laboratory 1 (SL1) supports locally based production operations of the MNE by assisting in the adaptation of the products to be produced or processes to be used. Its role is to help an associated production subsidiary to assimilate, and to optimize the effectiveness with which it uses imported group-level technologies. The Support Laboratory 2 (SL2) supports production operations of the MNE outside the local country by advising on the adaptation of the products to be produced or the processes to be used. It differs from the SL1 unit in terms of a higher intra-group interdependency and more individualized capabilities. However, the role of both types of laboratories is limited to supporting the application of existing knowledge. The Locally Integrated Laboratory (LIL) works with other functions of the local subsidiary (e.g., marketing, engineering) to develop new products for the markets served by the local subsidiary. “The LIL is a key element in a nexus of creative functions that helps to secure a product mandate (PM) for its subsidiaries. (…) How the PM/LIL operates

in terms of intra-group interdependencies is open to possible variations, however" (Papanastassiou and Pearce 2005, p.91). The Internationally Interdependent Laboratory operates independently of any production subsidiary to carry out basic or applied research. It is part of the overall corporate R&D network and cooperates with similar labs in other countries to enhance the MNE's existing stock of knowledge and thus to build the basis for future major innovations of the company. These units "avoid […] any immediate systematic integration with other functions (notably those related to the competitiveness of current products and technologies)" (p.94).

This taxonomy represents a further development of the typologies of laboratory roles formulated by Hood and Young (1982), Haug, Hood, and Young (1983), and Pearce (1989; 1997) and derives the categorizations with respect to the subsidiary's net knowledge flows. It is built along the two dimensions of "individualism" and "interdependence". Individualism describes the quality and originality of local scientific inputs, which allows the local R&D unit to generate distinctive in-house competences. This individualism within the group's technological scope can be exercised either autonomously through the local subsidiary, or in a highly dependent way (e.g., as a specialized element of the global corporate R&D network with central coordination). The authors state that "[i]n practice, labs can operate with carrying degrees of interdependence in terms of their association with technological activity elsewhere in their MNE group. Thus, a lab's degree of individualized competence, and the extent and nature of intra-group interdependency, will define its precise strategic role and determine its position with regard to knowledge transfer" (Papanastassiou and Pearce 2005, p.90). The authors suggest two so-called "forces of individualism" that drive companies to internationalize their R&D activities: Companies either intend to improve the competitiveness of their local subsidiary or want to benefit from country-specific technological strength. From a macro-perspective, they argue, these forces have "clear potentials to strengthen both local industry and local sciences (e.g., by, indeed, providing extra funding, as well as new challenges and access to additional technologies and perspectives), but do [..] so by enhancing interdependency with other globalised needs and priorities" (p.90). On a micro-perspective, this leads to the conclusion that a com-

pany can benefit from advantages of location by integrating the local R&D unit into the global corporate R&D network (i.e., in cases of high cross-boarder resource interdependencies).

After an extensive review of existing taxonomies, Medcof (1997) identifies seven dimensions to classify R&D units:

- Type of technical work being done (research, development, support)
- Collaborating business functions (marketing, manufacturing, both, none)
- Geographical area of collaborating units (local, regional, or international, referring to the location of all collaborating units)
- Organizational locus of output use (marketing, manufacturing)
- Geographical locus of output use (local, regional, international)
- Geographical locus of coordination (local, regional, international)
- Mode of establishment (green field foundation, incidental acquisition, intentional acquisition, conversion)

Possible combinations of these criteria would result in more than 5,000 laboratory types (Brockhoff 1998, p.61). Medcof bases his taxonomy of "overseas technology units" on the first three of the described dimensions and thus deduces eight types of R&D units: research unit, development unit, marketing support unit, and manufacturing support unit, and each of these four holds either a local or an international mandate. Brockhoff (1998) adapts this taxonomy and argues that that the main benefit of this classification scheme is that it encompasses several previous taxonomies.

Gassmann and Zedtwitz (1999) investigate organizational aspects of international R&D. They conclude that, despite the number of typologies of international R&D, a description of the dynamics of international R&D organization is still missing; in addition, they argue that "the development and change of concrete organizational configu-

rations (…) deserves more attention" (p.235). The authors classify MNEs according to the dispersion of R&D activities and the degree of cooperation between the individual R&D units. They distinguish between ethnocentric organized R&D, geocentric centralized R&D, polycentric decentralized R&D, R&D hub model, and R&D network. In the ethnocentric centralized R&D organization, all activities are concentrated in the home country; the geocentric centralized organization overcomes the ethnocentric home-base orientation while retaining the efficiency advantages of centralization. The polycentric decentralized hub describes companies with a strong orientation on the local market while the R&D hub with a home-based center tightly coordinates the smaller foreign laboratories. In the integrated R&D network, the different labs in different locations, without a centralized leading unit, corresponds to the "international interdependent laboratory" of Hakanson and Nobel (1993a; 1993b). Gassmann and Zedtwitz identify several trends of organizational change among these forms of international R&D organization and reach the conclusion that there is an optimal balance between coordination and control that is reflected by hybrid structures and intermediary configurations.

Authors	Dimensions	Strategies
Archibugi/ Iammarino (1999)	International exploitation of technology; Global generation of innovations; Global technological collaborations	International exploitation of nationally produced innovations Global generation of innovations Global techno-scientific collaborations
Bartlett/Ghoshal (1990)	Location of R&D activities; Intended market of R&D results	Local-for-local Local-for-global Global-for-global
Boehmer (1995)	Focus and intention of the R&D unit	Allround R&D unit with local focus Local problem solver Cooperating basic researcher Applied researcher Allround R&D unit with global focus
Gassmann/ Zedtwitz (1999)	Centralization; Behavioral orientation	Ethnocentric centralized R&D Geocentric centralized R&D Polycentric decentralized R&D R&D hub model R&D network
Gerybadze/ Reger (1999)	Market characteristics; Type of innovation	Large R&D base in home country Small R&D base in home country Lead market in home country Lead market abroad
Hakanson/Nobel (1993a, 1993b)	Focus and intention of the R&D unit	Market oriented units Production support units Research units Politically motivated units Multi-motive units
Hewitt (1980)	Use of R&D results; Location implications	Product Adaptive R&D Process Adaptive R&D Local Original R&D Global Original R&D
Iwasa/Odagiri (2004)	Main objective of subsidiary	Research-oriented (Type R) Local-support-oriented (Type S)
Kuemmerle (1997, 1999a, 1999b)	Type of activities (motivation) (knowledge-exploiting vs. knowledge augmenting)	Home-base exploiting site Home-base augmenting site

Table 2: Overview of International R&D Typologies and Taxonomies

Authors	Dimensions	Strategies
Le Bas/Sierra (2002)	Technological profile of home country; Technological profile of host country	Type 1 strategy: technology-seeking FDI in R&D Type 2 strategy: home-base-exploiting FDI in R&D Type 3 strategy: home-base-augmenting FDI in R&D Type 4 strategy: market-seeking FDI in R&D
Medcof (1997)	1) Type of technical work being done (research, development, support); 2) Collaborating business functions (marketing, manufacturing, both, none); 3) Geographical area of collaborating units (local, regional, international); 4) Organizational locus of output utilization (marketing, manufacturing); 5) Geographical locus of output utilization (local, regional, international); 6) Geographical locus of coordination (local, regional, international); 7) Mode of establishment (green field, incidental / intentional acquisition)	Local research unit Local development unit Local marketing support unit Local manufacturing support unit International research unit International development unit International marketing support unit International manufacturing support unit
Niosi/Godin (1999)	Diversification; Vertical integration	Internationally diversified Vertically-integrated firm Global networks
Patel/Vega (1999)	Location of technological advantage	Type 1: strong at host, weak at home Type 2: strong at home, weak at host Type 3: strong both at home and host Type 4: weak both at home and host
Nobel/Birkinshaw (1998)	Type of activity; Geographic scope	Local adapter International adapter Global creator

Table 2: Overview of International R&D Typologies and Taxonomies

Authors	Dimensions	Strategies
Pearce (1989); Pearce/Singh (1991)	Location; Collaboration; Internal ties	Support laboratory Locally integrated International interdependent laboratory
Pearce/ Papanastassiou (1999); Papanastassiou/ Pearce (2005)	Individualism; Interdependence	Traditional support laboratory (SL1) Locally integrated laboratory (LIL) Support laboratory role (SL2) Internationally integrated laboratory (IIL)
Ronstadt (1978)	Location of R&D activities; Intended market of R&D results (primary purpose at the time of establishment)	Technology transfer units (TTU) Indigenous technology units (ITU) Corporate technology units (CTU) Global technology units (GTU)
Zander (1999)	International duplication; International diversification	Home-centered Internationally duplicated Dispersed Internationally diversified
Zedtwitz/ Gassmann (2002)	Dispersion of research and development activities	National treasure R&D Technology-driven R&D Market-driven R&D Global R&D

Table 2: Overview of International R&D Typologies and Taxonomies

This discussion shows that there is a variety of dimensions and taxonomies in the classification of international R&D. Table 2 (based on Brockhoff 1998; Medcof 1997; Niosi 1999) provides an overview of strategies and dimensions used in literature. Some of the more recent publications refer to the dichotomous differentiation between knowledge exploitation (“traditional view”) and knowledge creation (”new view”). However, there is no widely accepted standard in the scientific community yet – neither with regard to the terminology nor with regard to the underlying dimensions. Even in case of identical dimensions, different labels are applied. Ambos (2005) concludes that the diversity of schemes “indeed leads to some confusion on how to classify investments” (p.402). While each of these typologies has its specific merits, none of

them differentiate between strategies that are directly measurable and action-oriented. Most of the existing typologies categorize subsidiaries in different types of R&D roles. Although such categorizations offer insights into potential tasks and missions, they are of a static nature: They do not allow the measure of gradual differences and hardly can address "the interesting question […of] what we know about the change of missions and tasks" (Brockhoff 1998, p.62). The lack of measurability prevents the comparison of strategies with macro-economic indicators, which could help to assess geographic differences or emerging shifts in configuration strategies. Moreover, because of the lack of action-orientation, existing typologies do not allow for prescriptive strategy recommendations for international R&D based on situational variables.

2.3 Research Gap

Internationalization of R&D has long been a neglected topic in management research. Despite its growing importance and the burgeoning literature (Penner-Hahn and Shaver 2005), the field of internationalization of R&D is still at a relatively early stage of theory development (Feinberg and Gupta 2004; Frost 2001) and could benefit from insights of empirical research (Manolopoulos, Papanastassiou, and Pearce 2005). The preceding literature review reveals several areas that call for further research. The identified limitations and gaps that this thesis aims to address are summarized in the following paragraphs.

Regarding *content,* most prior research builds on typologies that group R&D activities into distinct categories. The conceived strategies are often limited to a dichotomous set of R&D roles or are not of a disjunctive nature, which inhibits the measurement of both gradual variations between foreign R&D units and incremental developments over time. Moreover, existing frameworks usually are not defined along practical action dimensions. They usually do not differentiate between the dimensions used to measure the strategy variables (endogenous action) and drivers or motives that are

expected to influence the choice of strategy (exogenous pressure). Consequently, there is a lack of research on the conditions that induce MNEs to configure their R&D in a certain way (see Song and Shin 2008). Furthermore, much of the prior research that investigates motives of R&D internationalization models R&D location as a matter of the firm's choice between home and foreign country location factors. Differences between alternative foreign locations often are not considered. Previous studies have also been relatively silent on industry-related differences (see Hegde and Hicks (2008) for similar findings). Contextual factors, such as technological complexity and cost pressure in an industry, are salient determinants of the configuration of value creation because they create sustained external pressures and constraints to which foreign subsidiaries must adapt and react (Luo and Park 2001). Moreover, a substantial part of the discussion in literature focuses on R&D at the MNE group level or the entire global R&D network. There is a dearth of literature addressing influencing factors on international R&D on the basis of individual foreign subsidiaries (see Cantwell and Mudambi (2005) Davis and Meyer (2004) for similar findings). Kumar (2001) asserts that only "limited attention […] has been paid in the literature to an analysis of locational factors of overseas R&D" and concludes that "[a] more comprehensive and detailed analysis of factors that make a country […] attractive as a potential location for R&D investments by MNEs remains to be made" (p.164). Despite the growing importance of literature on subsidiary roles and location-specific factors, Enright (2009) recently has pointed out that "the activity basis of multinational subsidiaries is an under-researched topic" (p.819). Formal tests of the relationship between host country-related factors and the configuration of subsidiary R&D remain scant. Extant studies are partial in nature, including only some selected variables relevant in the choice among alternative R&D configurations. No study could be identified that provides a comprehensive, quantitative analysis of the relationship between drivers and R&D configuration on the level of the individual subsidiary. Perlitz (2004, p.447) notes that with regard to the internationalization of R&D there is as yet no comprehensive, integrative, and widely accepted concept.

From a *context* perspective, most of the existing studies analyzing R&D decentraliza-

tion in MNEs in an international context focus on the developed industrial economies in the triad regions as host countries, namely the United States, Europe, and Japan (Edler, Meyer-Krahmer, and Reger 2002; Tsang, Yip, and Toh 2008; Zedtwitz and Gassmann 2002). This trend particularly holds for studies that apply the method of patent data and patent citation analysis because of the availability and accessibility of the respective data. Despite their increasing importance as R&D locations for MNEs, hardly any empirical work has been done on the particular characteristics of foreign R&D activities in less technologically and industrially developed middle-level or emerging economies. A few exceptions, such as Gassmann and Han (2004) and Zedtwitz (2004), who investigate foreign R&D activities in China, are based on qualitative case research. Ambos and Ambos (2009a) assert that "[t]he question to what extent firms invest in R&D in non-triad economies remains fairly uncharted territory" (p.24) and conclude that "it has hopefully become evident that this is an exciting and promising field of research which calls for further studies" (p.38). This appraisal is consistent with Sachwald (2008), who finds that "[t]he observation of foreign R&D in emerging countries should be a fertile research ground for the years to come" (p.376). Similarly, Narula and Dunning (2000), Manolopoulos, Papanastassiou, and Pearce (2007), Yang and Jiang (2007), and Boehe (2008) emphasize the lack of understanding in this context and the need for further research. Moreover, most prior research is constrained by examining foreign R&D in a very specific setting, such as one industry, one target country, or one single home-host country pair only. This selection likely provides an incomplete perspective and limits the identification of important theoretical motivations (see Chung and Yeaple 2008). Furthermore, existing literature on internationalization of R&D often lacks explicit attention to managerial action. With regard to managerial aspects, Gammeltoft (2006) finds that, apart from a few publications, "(…) such contributions are indeed rare" (p.190). There are also studies that consciously avoid the perspective of practical relevance. Papanastassiou and Pearce (2005), for instance, explicitly state that "[t]he aim of this paper is not to provide a guide to contemporary management practice" (p.90).

Regarding *theory*, the discussion of internationalization of R&D seems to be rather

independent of other IB-related fields and theory strands. Parts of the research field have "largely missed the opportunity for theoretical advancement" (Frost 2001, p.101). Early studies in the field of internationalization of R&D have generally followed an international product life cycle model as developed by Vernon (1966). However, this theoretical framework does not account for the emerging importance of supply factors that appear to drive some R&D investments abroad (Cantwell 1995). More recently, a new perspective looks toward a capability- and learning-based view. However, existing literature fails to include comprehensive internationalization theory when investigating factors that are related to the configuration of foreign R&D activities. Moreover, Burgess and Steenkamp (2006) find that "[emerging market] institutional contexts present significant socioeconomic, demographic, cultural, and regulative departures from the assumptions of theories developed in the Western world and challenge our conventional understanding of constructs and their relations" (p.338). Thus, there is a need for an integrated study that: 1) comprehensively analyzes the drivers of R&D configuration on the basis of different IB theory strands and 2) considers these established theories in the context of emerging economies.

With regard to *methodology*, there is a shortage of survey-based empirical work dealing with large sample environments. In particular, both earlier studies and more recent work on foreign R&D in a nontriad-country context rely on qualitative research methods. Only recently, Ambos and Ambos (2009a) noticed that "researchers will have to conduct larger scale analyses to gain more insights into this field" (p.38). So far, little effort has been made to overcome the fragmented and descriptive nature of most studies. Extant quantitative studies in the field of international R&D generally rely on aggregated government or patent data. Although these studies are able to generate large sample sizes, they usually stay on an aggregated country- or industry-level analysis and do not provide insights at the firm or even the subsidiary level.

To conclude, existing literature provides only a limited understanding of how firms configure their R&D activities in emerging economies and why they choose one strategy over another. Thus, this thesis aims to address the following

research gaps:

- *Content issues*: Foreign R&D typologies mainly categorizing character but missing the differentiation between strategy dimensions and motives; limited understanding of the reasons why firms use these strategies; limited consideration of influencing factors on the subsidiary level and mainly a narrow focus (home vs. host country R&D)
- *Context issues*: Primary focus is on triad countries, emerging economies as host countries only marginally covered; constrained by investigating specific settings (e.g., one industry, one home-host country pair)
- *Theoretical issues*: Scant literature comprehensively investigates strategies and motives of MNEs' R&D configuration, building on internationalization theory strands
- *Methodological issues*: Limited number of large-scale investigations taking a detailed, differentiated perspective on the drivers of foreign R&D activities

To address the identified deficiencies and to provide a contribution to extant research, the present study aims to provide an understanding of different reasons for firms' R&D configurations in emerging economies. It focuses on the following elements:

- *Content*: To provide a more complete sense of foreign subsidiary R&D, the study separates and assesses the characteristics of the configuration strategy and the relative importance of motives determining the choice of the configuration. It builds upon motives that were discussed separately in different contexts and related fields and evaluates these multiple motives simultaneously in an integrated model. The developed typology of subsidiary R&D strategies allows for the measure of gradual differences between and changes in configurations. Moreover, the underlying action-oriented dimensions of the strategies, which are structured along endogenous outcomes rather than along exogenous pressures, provide a useful framework for busi-

ness practice. To overcome the constraints of aggregated analysis on the industry, regional, or MNE level, this study considers the individual foreign subsidiary as the unit of analysis, which allows for the investigation of subsidiary-level influencing factors, as well as intersubsidiary variations in R&D configuration (see Chapter 5, the section titled Research Object, for details).

- *Context*: To overcome the constraints of extant literature, this study systematically analyzes strategies and motives of R&D activities in alternate foreign locations. It focuses on R&D activities in emerging economies and uses a broad empirical sample covering multiple countries and industries.
- *Theory*: To provide a comprehensive, top-down perspective of the phenomena under investigation, this study follows a pluralistic theory approach. It builds upon strands of trade, FDI, and IB theory and integrates prior literature on internationalization of R&D, corresponding to recent calls to integrate different theoretical perspectives when considering international strategy in emerging economies. This thesis aims to extend the existing literature in that it systematically models the influencing factors for the choice among R&D configuration strategies.
- *Methodology*: The study uses unique subsidiary data, with subsidiary heads as key informants, that encompass the most important emerging countries. Structural equation modeling is applied for data analysis in the large-scale environment.

3 Theoretical Foundations

This chapter describes the theoretical points of reference for this study. As discussed in the literature review, in the field of international R&D there is a high degree of diversity with regard to the nature and degree of theoretical foundation. This diversity, on the one hand, relates to the different conceptual points of view from which international R&D activities are investigated, such as technology and innovation management, IB, economics, strategic management, and HR management. On the other hand, it also reflects that IB theory itself is not a homogenous body and consists of various strands that often are not reconciled or integrated (see Weisfelder 2001). Combining several theoretical points of reference from IB is therefore considered reasonable to derive a research framework that provides a comprehensive perspective of foreign subsidiaries' R&D configuration. Thus, the study at hand follows a pluralistic theory approach to account for the multifarious aspects and motives of international R&D strategies. This is also consistent with Dunning (1997, p.61), who argues that to understand the extent and pattern of foreign value-adding activities, researchers need to draw upon several separate but interrelated strands of theory. Moreover, this approach adds to recent calls to integrate different theoretical perspectives when considering international strategy in emerging economies (Meyer and Peng 2005; Wright et al. 2005).

This study follows the concept of contingency theory, which serves as an overall frame for the research approach and is briefly described in the following chapter. The subsequent chapters outline the theoretical points of reference for the different elements of the research framework comprising selected strands of IB, trade, and FDI theory. These theories have been intensively discussed in literature; the discussion therefore mainly focuses on key aspects and expected contributions relevant for this research context.

3.1 Contingency Perspective

Contingency theory, also called ”situational approach“, is of central importance in strategy and organizational research (Hambrick and Lei 1985). It goes back to the work of Barnard (1938) and Dill (1958) and has been developed by multiple scholars – notably, Burns and Stalker (1961), Woodward (1965), Emery and Trist (1965), Lawrence and Lorsch (1967a; 1967b), Thompson (1967), and Blau and Schoenherr (1971).

The central proposition of the contingency theory is that organizational strategies are not equally effective under all conditions. There is no universalistic organizational choice that results in optimal outcomes (Ginsberg and Venkatraman 1985). Instead, the optimal strategy is contingent (i.e., dependent upon the context). Organizational choices must therefore be matched to the contingency or situational variables. The “fit” between the organizational design and the competitive setting of the business determines the organizational performance (Pfeffer and Salancik 1978). External factors, such as environmental dynamism, and internal factors, such as organizational size, strategy, or degree of internationalization, represent contingencies that have received much research attention (e.g., Burns and Stalker 1961; Chandler 1962; Child 1975; Stopford and Wells 1972).

Even with its widespread application, contingency theory belongs to the most controversially discussed theoretical approaches (Wolf 2003) and has been subject to severe criticism. Some scholars doubt whether contingency theory fulfils the prerequisites of a theory. According to Bacharach (1989), contingency theory represents a “tautology” rather than a theory because its tenets are true by definition and therefore cannot be falsified. Schoonhoven (1981) therefore understands the contingency approach as an “orienting strategy or metatheory, suggesting ways in which a phenomenon ought to be conceptualized” (p.169). A further criticism relates to the deterministic nature of the relationship between environment, structure, and performance. The notion that organizational structure and performance is only determined by envi-

ronmental variables neglects the influence of discrete managerial decisions, as well as strategic positioning of the organization (Schreyögg 1978, 1996; Zeithaml, Varandarajan, and Zeithaml 1988).

Despite these limitations and critiques, the fundamental approach of the contingency perspective represents a suitable overall frame of reference for the framework of this study. International R&D configuration strategies are supposed to be influenced by external location- and industry-based environmental factors. Regarding the contingency perspective on knowledge transfer, Hutzschenreuter and Listner (2007) assert that literature has often explored context and configuration in an isolated way and "largely ignored the fits between both" (p.136). Although the contingency perspective represents the overall frame of reference, the deduction of variables and hypotheses for this study require additional theories allowing the development of predictive statements. This approach follows the recommendation of Kieser (1999) and is in line with prior research (e.g., Kaufmann 2001).

3.2 Trade and FDI Theories

In international management research, trade, FDI, and IB theory serve as foundations to explain MNEs' international activities. Neither trade nor FDI theory is an homogenous body. Rather, they make up different strands that identify and explain cross border trade and investments, respectively, from different perspectives. Each strand of trade and FDI theory can only partially explain cross-border trading (see Leonidou and Katsikeas 1996, p.518) and investment (see Agarwal 1980, p.763) behavior. Some of these strands make relevant contributions to our understanding of the configuration of MNEs' international R&D activities: They both serve as basis for the later described IB theory strands, which are characterized by their power to explain both trade and FDI, and add complementary perspectives for the research framework and its operationalization. The approaches that are most relevant for this study are introduced in this section. Because these traditional theories enjoy great popularity and

have been intensively discussed in the literature, our remarks are deliberately limited to key aspects.

This chapter is divided into two parts. The first section focuses on theories related to trade, the second to theories related to FDI. For a comprehensive overview, see e.g., Morgan and Katsikeas (1997), Welge and Holtbrügge (2006), or Kutschker and Schmid (2008).

3.2.1 Trade Theory

Cost advantages on the factor market as motive for cross-border trade goes back to Adam Smith (1776) and his famous work, *An Inquiry into the Nature and Causes of the Wealth of Nations*. Ricardo (1817) expanded the principle of *absolute cost advantage* by adding the principle of *relative cost advantage*. Both principles assume a macroeconomic perspective and argue that differences in the production functions of countries lead to specialization of production and resulting trade flows. Absolute advantage theory asserts that a country specializes in the production of a good that it is able to produce at higher productivity and efficiency (i.e., with fewer resources) compared to another country. This advantage might result from differences in labor productivity, skills, experiences, or economies of scale. The principle of relative advantage assumes that specialization and trade also occur even if one country has no absolute but only a comparative cost advantage. This aspect refers to a country's ability to produce a particular good at a lower opportunity cost.

In response to Smith and Ricardo, Heckscher (1919) and Ohlin (1933) developed the Heckscher-Ohlin theorem, also known as the *factor proportion theorem*. Rather than gearing solely to differences in labor productivity, they considered relative differences in factor endowments between countries as determinants of international trade. They distinguish between labor and capital as production factors and assume that countries specialize in the production of goods according to their endowment in these factors. The greater the supply of a production factor, the lower its costs. The abundance of

one factor favors specialization in goods that differ with respect to this factor. Consequently, countries export goods that use their abundant and cheap factor of production and import goods that require their scarce factor. Thus, developed countries that are rich in capital are assumed to export capital-intensive goods, while emerging countries that are rich in labor are expected to export labor-intensive goods. However, the empirical investigation of Leontief (1956) found contradicting results. He explained his finding, which is known as the ”Leontief paradox“, by asserting differences in the quality of the countries' factor endowments; the Heckler-Ohlin theorem, meanwhile, is based on an assumption of homogenous production functions and factor quality (Balassa 1963). These differences in the qualification of labor are also referred to as “human capital” (van de Ven 1989, p.14). According to this theorem, countries with a high level of qualification specialize on and export knowledge-intensive goods and in return import goods that require a lower degree of qualification and skills.

Criticism of the described trade theories is based on their simplistic assumptions of neo-classic theories. It concerns, amongst others, the assumptions of fixed factor endowments, full employment, complete factor immobility, and perfect mobility of goods, as well as perfect information about products. Although trade theories mainly relate to products, they contribute to this study by highlighting that location-specific differences in factor endowments, which may translate into cost differences for MNEs (Ghoshal 1987, p.432), affect trade and investment decisions. Comparative cost advantages are the basis for MNEs' competitive advantages. Thus, it can be deduced from these trade theories that location-specific features in factor endowments are an important factor for the international configuration of value creation activities. According to this view, FDI in R&D will likely appear in countries that possess a large pool of highly skilled engineers that are capable of engaging in R&D (see Ambos and Ambos 2009a).

The *technology gap theory*, which goes back to Posner (1961) and Hufbauer (1966), proposes that trade occurs because of differences in the technological development of countries. According to this strand, a new technology is developed in one country

and first sold domestically. In a second step, demand for this product also occurs in a foreign country and is, after the so-called ”demand gap“, exported there to serve foreign customers. After a certain time – the so-called “imitation gap” – exports decline because local companies in the foreign country are then able to offer the same innovative products in their home market. Reverse trade flow might even occur if companies in the foreign country can achieve additional competitive advantage, such as superior technology or lower cost. The latter particularly applies for activities in emerging countries. Technology gap theory has been empirically verified in numerous studies (e.g., Battisti and Pietrobelli 2000; Lee and Suh 1998; Lowe and Fernandes 1994; Müller-Merbach 1994) and represents the foundation of the (IPLC) model by Vernon.

The strands described thus far primarily attribute cross-border trade to the characteristics of a country’s supply conditions; the *demand structure hypothesis* by Linder (1961) ascribes trade to characteristics on the demand side. According to this view, trade occurs between countries with similar demand structures, such as income per capita or quality expectations. Each country specializes in specific products or types of product. First, the domestic market potential and later the bundling of demand across borders allows companies to realize economies of scale and thus generate a competitive advantage over foreign competitors. This strand stresses the importance of economies of scale originating from centralizing activities for different countries. Moreover, in contrast to the previously discussed strands that primarily explain complementary intra-industry trade, the demand structure hypothesis allows for the explanation of two-way, intra-industry, substitutive trade. Substitutive trade is likely to gain further importance because demand structures actually tend to converge globally (Levitt 1983). Finally, the fixed-cost argument of Linder’s demand structure hypothesis can also be extended to intra-company trade because the same line of argument holds for subsidiaries in different countries. High fixed costs and the derived necessity to achieve economies of scale are important characteristics of R&D activities that influence decisions on international centralization and decentralization, respectively. The demand structure hypothesis also recognizes that similar customer preferences might represent a prerequisite for cross-border volume-bundling.

3.2.2 FDI Theory

FDI theory explains why firms invest and conduct business in foreign countries. One of the most cited explanations for FDI is the *monopolistic advantage theory* (Kutschker and Schmid 2008) , also referred to as the theory of market imperfections (Malhotra, Ulgado, and Agarwal 2003). It relates to a strand of industrial organization theories (Buckley 1981) and goes back to Hymer (1976) and Kindleberger (1969). According to these theories, MNEs directly invest abroad to control their foreign activities; such investment allows them to take advantage of market imperfections that overcompensate for the existing difficulties when they expand abroad into new markets. These difficulties, also called “barriers to international operations” (Hymer 1976), or the liability of foreignness (Zaheer 1995; Zaheer and Mosakowski 1997), describe “obstacles, which all favor the local competitors under normal circumstances” (Rayome and Baker 1995, p.4), such as differences in culture, language, and the institutional environment, as well as transportation, coordination, and communication costs (see Cuervo-Cazurra, Maloney, and Manrakhan 2007, p.710). Meanwhile, monopolistic advantages for foreign companies might arise from imperfections on the goods market (e.g., product differentiation), on the factor markets (e.g., patented or superior technology), on scale advantages (e.g., economies of scale), or artificial market imperfections (e.g., tariffs). Monopolistic advantage theory contributes in this respect to motives and barriers of R&D localization. In particular, this strand of FDI theory can be considered a precursor to the resource-based view (RBV) of strategic management (Barney 1986, 1991, 2001; Wernerfelt 1984) and the capability perspective of IB (Gupta and Govindarajan 1991, 1994), which postulate that foreign affiliates not only can exploit firm-specific advantages and capabilities but also can augment existing capabilities and contribute new ones by internalizing and transferring location-specific knowledge.

The concept of investment barriers is complemented by the *trade barrier approach* (Cordon 1967; Johnson 1967). This strand argues that companies locate value creation activities abroad to overcome trade barriers. These barriers can consist of both

tariff (e.g., customs duties) and non-tariff (e.g., technical requirements and standards) government interventions. Whereas investment barriers hamper FDI, trade barriers are expected to foster FDI. Particularly non-tariff barriers might lead to the localization of R&D activities in the respective foreign country to facilitate the adaptation of products to the requirements of the local market.

The importance of industry-specific factors and competitive aspects of market opportunities is emphasized by the *oligopolistic parallel behavior theory*. This strand is based on Knickerbocker (1973) and also is sometimes referred to as strategic behavior theory (Malhotra, Ulgado, and Agarwal 2003). It assumes that industry structures in both the home and the host countries determine the localization of value creation activities. FDI is triggered by a disruption of the oligopolistic equilibrium. This follow-the-leader concept assumes a disruption in a home market by a competitor that makes investments abroad (i.e., outside its home market). This foreign investment allows the competitor to gain competitive advantages (e.g., by improved customer accessibility and responsiveness or realization of economies of scale). In turn, these perceived advantages cause other participants in that competitor's home market to follow and also carry out FDI in the respective host country. The cross-investment concept, on the other hand, assumes a distortion of the equilibrium by a foreign competitor that enters the firm's home market. In return, that home market's incumbent invests in the entrant's home market.

The nature of competition between firms from advanced economies and firms from low-cost countries differs fundamentally from the competition between companies originating from developed countries. While MNEs from developed countries share access to similar technologies and resources, firms from emerging economies might lack the latest technologies and certain resources, yet enjoy labor cost advantages (Kaufmann and Körte 2010). Hence, for the purposes of this research, the follow-the-leader concept seems especially well suited because it can be expected that if a competitor from a Western MNE's home market invests in a foreign country and localizes R&D activities in the host country to induce and facilitate the penetration of the

foreign market, other firms are likely to follow with FDI in R&D.

3.2.3 International Business Theory

Whereas trade and FDI theory intend to explain either exports or localization of value creation activities abroad, IB theory, sometimes also referred to as internationalization theory, takes a more integrative approach and intends to explain both forms of internationalization in one concept; it seeks to explain why, when, where, and how to internationalize (Morgan and Katsikeas 1997). Like trade and FDI theory, IB theory is no homogenous body of literature. Instead, different approaches try to explain internationalization from different perspectives. Most strands have in common that, in contrast to trade and FDI theory, they argue from a business level rather than from an economic perspective. In the following paragraphs, the approaches that are most relevant in the context of this study are considered.

Particularly earlier studies investigating internationalization of R&D generally follow the IPLC model of Vernon (1966; 1977; 1979). This model provides an explanation of why MNEs might not shift their R&D abroad (see Lall 1979, p.319). Sophisticated R&D activities and major product innovation are concentrated at the headquarters in the home country, allowing efficient communication and coordination among researchers, management, and sophisticated customers (see Hegde and Hicks 2008, p.391); R&D activities abroad are limited to customize products and processes to the local host country requirements. The IPLC model, also called the product cycle hypothesis, has been frequently cited and enhanced by different scholars (e.g., Fröbel, Heinrichs, and Kreye 1980; Grunwald and Flamm 1985; Malhotra, Ulgado, and Agarwal 2003; Wells Jr 1968). It builds on the product life cycle theory from marketing (see Levitt 1965) and transfers the concept to an international context. This theory strand assumes that products go through different phases over time. Firms undertake exports, FDI, and imports depending on the stage of the technological development. In contrast to the technology gap theory (Posner 1961), the IPLC model considers company level rather than country level differences. According to the IPLC model, a new

product in the innovation phase is first developed, produced, and sold in the domestic market. In this stage, flexibility in production, highly skilled labor, and intensive communication with and input from key customers are essential success factors. The innovative technology allows a high degree of product differentiation and thus a high market price. Emerging foreign demand is satisfied via exports. With growing maturity, domestic demand and foreign demand increase, and production facilities are built in industrialized countries to satisfy the greater demand. FDI becomes plausible when technological stability allows the decoupling of manufacturing and domestic R&D. Moreover, higher sales volumes allow decreasing unit costs. At the same time, competitors are able to close the imitation gap and start imitating the product. Vernon (1966) proposes locating foreign manufacturing sites in countries with similar demand structures to those of the home market. In the final stage, the product is fully standardized, and know-how with regard to product and manufacturing process technology is widespread and largely codified. Because price represents the competitive factor and there are fewer requirements with regard to employee qualification and technological know-how, costs determine the location of the manufacturing site. Consequently, emerging economies offer attractive locations for manufacturing activities. Domestic production is fully relocated, and components or finished products are exported from the host country to the home country of the MNE.

With regard to the location of R&D activities, IPLC theory assumes that the MNE's innovation is created in its home country and then adapted to the requirements of foreign markets. The home market thus plays two roles: It represents both the "source of stimulus for the innovation" and the "preferred location of the actual development of the innovation" (Vernon 1979, p.256). Consequently, the IPLC argues for a centralization of R&D activities in the MNE's home country. It maintains that MNEs undertake overseas R&D activities solely to adapt their products and processes to local markets. Foreign R&D units are supposed to provide technical support to the foreign subsidiary, such as adapting established product and process technologies to the particular condition and/or helping others to use those applications (Medcof 1997, p.303). According to Manolopoulos, Papanastassiou, and Pearce (2007), there are two factors

that cause the “initial implicit rejection” (p.662) of foreign R&D: On the one hand, the theoretically derived limited mission of foreign R&D units (i.e., to adapt the centrally derived technological capacities to local market and input conditions) and, on the other hand, the “overwhelming” emphasis on centripetal forces (e.g., economies of scale, communication and coordination costs, and intellectual property protection).

Despite the IPLC theory’s frequent application, several points of criticism have been discussed in literature. For a discussion of general points of criticism, see Buckley and Casson (1976) and Giddy (1978). With respect to internationalization of R&D, Penner-Hahn (1998) argues that the IPLC “was perhaps appropriate for stable industry environments, but it is less suited to current environments in which firms face many challenges that require competitive response” (p.149). These more current challenges include increasing foreign and domestic competition. He concludes that MNEs undertake foreign R&D activities as a response to increased competition within their industry, both in their home markets and throughout the world, rather than as a support function for existing sales operations in a host market. Moreover, IPLC is criticized because it insufficiently explains the increasing conduct of R&D activities, which are located independent of product demand and manufacturing sites (Hegde and Hicks 2008,p. 391).

Despite this criticism, IPLC contributes to the explanation of the extent and type of international R&D activities. It identifies technological characteristics, product life cycle stages, and market opportunities as critical determinants of foreign R&D activity locations. Moreover, it provides a reference with respect to the location of manufacturing activities (i.e., whether products are likely to be moved to an emerging country or whether manufacturing remains in the home country).

The *internalization theory*, which was established by Buckley and Casson (1976) and further developed by scholars such as Rugman (1980; 1981a; 1986) , Hennart (1982; 1989; 1993), and Teece (1981; 1986) can be considered as one of the most important streams in IB research (see Hennart 1996). For more comprehensive reviews on the

theory, see Dunning (2003) and Safarian (2003). Internalization theory builds on transaction cost theory (Teece 1976; Williamson 1975, 1985) as an overarching perspective and focuses on ownership of firm-specific advantages that firms can transfer to other countries for economic benefit. According to this view, firms apply FDI whenever the transfer of the firm-specific advantages is subject to high transaction costs (Brouthers and Hennart 2007; Buckley and Casson 1998). Thus, firms establish foreign subsidiaries if they posses certain firm-specific advantages that are valuable abroad and if the best way to transfer them is by an internal mode of coordination.

According to this view, foreign subsidiaries exist to extend abroad the parent firm's firm-specific advantages. The theory stresses intangible assets, such as firm knowledge on technical or marketing activities (Dunning 1988; Hennart 1982), and emphasizes the protection of the value of a firm's knowledge when penetrating foreign markets (Penner-Hahn 1998) Consequently, subsidiaries' R&D activities are arranged according to the R&D of the parent company (Rugman 1981b, p.216). Rugman (1981a) summarizes:

> "[T]he theory of internalization predicts that R&D expenditures by subsidiaries do not result in genuine innovation but only adaptation of techniques at best. Instead, the subsidiaries exist primarily as extensions of the parent firm, and their business is to safeguard the market of the MNE in the host nation. […] The role of the subsidiary is supportive to the R&D function of the parent, and it cannot be an innovator. […] Consequently, there is relatively little R&D done in the subsidiary" (pp.135-137).

In terms of conclusions, this perspective is therefore rather consistent with the IPLC model. Scholars criticize that, as the competitiveness of firms becomes increasingly dependent on their ability to access foreign knowledge and capabilities (Dunning 1997; Kuemmerle 1997), "such a centralized conception of R&D is no longer sufficient" (Le Bass and Sierra 2002, p.590). On a more general level, Rugman and Verbeke (2001) argue in the same direction when asserting that "the internalization per-

spective was useful in explaining the transformation of domestic firms into MNEs within the institutional context of the 1960s and 1970s, when most organizational structures of the MNEs were hierarchical and centralized" (p.238). However, in terms of current patterns of parent-subsidiary relationships and network relationships, internalization theory suffers from some weaknesses. Issues related to the adaptation and codification of intangible firm-specific advantages are hardly considered. Moreover, the approach lacks a dynamic component in terns of organizational learning and local subsidiary-level initiatives. Finally, internalization theory focuses on cost optimization and protection of capabilities rather than considering the creation of new capabilities (see Zhao, Luo, and Suh 2004, p.541) . To overcome this point of criticism, Rugmann and Verbeke (2001, p.248) suggest distinguishing between different types of competencies: non-location-bound, firm- specific advantages that can be exploited globally and are easy to diffuse; location-bound advantages that lead to the benefits of national responsiveness and are difficult to diffuse internally; and subsidiary-specific advantages that combine the benefits of global exploitation of know-how with difficulty in its internal diffusion. This view implies that the non-location-bound knowledge created or absorbed by a foreign subsidiary can be codified and transferred to other subsidiaries through the knowledge-sharing routines and infrastructure that constitute the internal networks of the MNE (Asmussen, Pedersen, and Dhanaraj 2009). Thus, MNEs potentially can use FDI in R&D to access sources of competitive advantage while subsidiary exports arise from resources that are both firm-specific and location bound (Estrin et al. 2008, p.576). The argument that firms create value by combining internationally dispersed knowledge fits this perspective, particularly if one presumes that markets often fail to transfer this knowledge (see Ambos, Ambos, and Schlegelmilch 2006).

Following a different logic, Kogut (1988) and Kogut and Zander (1993) come to a similar conclusion regarding the MNE as a knowledge integrating institution. Building on *evolutionary theory* of the firm, they provide a complementary view to internalization theory (Penner-Hahn 1998). This "newer perspective on innovation and the MNE sees the MNEs as evolutionary learning organizations, which create (and draw upon)

a regular and cumulative flow of knowledge and capabilities from locationally differentiated sources" (Cantwell 2009, p.38). Thus, MNEs create networks of subsidiaries that are interconnected by knowledge flows (Adler and Hashai 2007). Internationalization of R&D activities is explained in terms of transfer and recombination of knowledge. Firms accumulate knowledge over time by combining existing domestic knowledge with what they learn in foreign markets (Almeida 1996; Almeida and Phene 2004; Frost 2001). Ambos, Ambos, and Schlegelmilch (2006) and Phene and Almeida (2008) assert that this perspective fits well with the literature on transnational, heterarchical, or multi-focal firms (Bartlett and Ghoshal 1988; Birkinshaw, Hood, and Jonsson 1998; Ghoshal and Bartlett 1994; Ghoshal and Nohria 1993; Hedlund 1994). The common notion is that all subsidiaries of a MNE belong to the same social community and therefore should be able to assimilate knowledge both from the headquarters and other subsidiaries. Whereas the internalization perspective regards the MNE as a result of market failures and emphasizes protecting the value of existing knowledge, evolutionary theory emphasizes the MNE's ability to acquire, combine, and integrate new knowledge on a world scale to gain technological advantages as sources of the MNE's competitive advantages (Shan and Song 1997). Applying this view suggests that both existing capabilities and the need for new capabilities are important drivers of R&D internationalization. Specifically, country-specific technological advantages (Kogut 1990) and superior national innovation systems (Edquist 1997; Lundvall 1992; Nelson 1993) might attract foreign R&D activities to tap into local "pockets of knowledge" (Asakawa 2001a; Chiesa 1996a)

This study draws on both the protection perspective and the learning perspective. Taken collectively, both perspectives consider MNEs as a network of differentiated roles and responsibilities in which the access to internal and external knowledge networks enables the organization to continuously create and renew its technical and competitive advantage (Nohria and Ghoshal 1997). Internalization theory stresses the exploitation and protection of firm-specific technological knowledge. Moreover, it adds the importance of considering challenges in coordination, such as differences in culture and language. Meanwhile, evolutionary theory adds a view on location-specific

characteristics of the host country, such as country-specific technological advantages and subsidiaries' contribution to the international company network.

A related stream of literature focuses on the role of the individual subsidiary to model knowledge flows. Gupta and Govindarajan (1991; 1994; 2000) and Tallman and Fladmoe-Lindquist (2002) enhanced the concept of worldwide learning and capability accumulation by emphasizing the role of "outside-in" knowledge flows at the subsidiary level. The basic perspective of the *capability-driven framework of internationalization* is in line with a growing body of research that builds on the idea of the MNE as a network of specialized, interdependent units (Bartlett and Ghoshal 1989; Hedlund 1986; Nohria and Ghoshal 1997; Westney 1990). The capability-driven framework of internationalization builds on the dynamic capability perspective of strategic management, which represents an extension of the resource-based view (Barney 1986, 1991, 2001; Wernerfelt 1984). In contrast to the resource-based view, which assumes that firms' competitive advantages come from rare, inimitable, and nonsubstitutable resources, the dynamic capability perspective argues that competitive advantage can be gained by effectively reconfiguring or using homogenous resources under different environmental conditions (Eisenhardt and Martin 2000) and create new products and processes to respond to changing market conditions (Helfat 1997). Teece, Pisano, and Shuen (1997) define dynamic capabilities as a firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments. In particular, this definition might hold in the study of emerging economies (see Hoskisson et al. 2000, p.257). The capability-driven framework of internationalization thereby transfers the fundamental idea of inter-partner learning to an international level and assumes inter-country learning between foreign subsidiaries.

This perspective asserts that firms invest abroad to gain access to new capabilities. These capabilities are internalized and exchanged with other entities within the MNE and thus contribute to the worldwide learning of the organization. To benefit from different host country characteristics as sources of competitive ownership advantage (Papanastassiou and Pearce 1994a), a firm needs both to offshore value creation

activities and to integrate these activities into a network structure. Thus, competitive advantage comes from a firm's "unique potential for radical innovation by melding and leveraging distinctive knowledge drawn from diverse geographical contexts around the world" (Doz, Santos, and Williamson 2003, p.154). This view includes both the building and the leveraging of capabilities. Gupta and Govindarajan define subsidiaries' strategic roles according to the extent to which the subsidiary is a user of knowledge from the rest of the corporation (knowledge inflows) and the extent to which the subsidiary is a provider of such knowledge to the rest of the group (knowledge outflows). In such a networked MNE, the role of individual subsidiaries is much more complex than in the "traditional" global or multinational firm because each subsidiary can simultaneously be a recipient and a contributor of knowledge, products, and services (Gupta and Govindarajan 1991). They argue that because of an international dispersion of specific knowledge and declining technological gaps among countries (Gupta and Govindarajan 1994, p.445), foreign subsidiaries have begun turning into major knowledge creators for the entire MNE. By building dispersed and specialized competencies in their foreign subsidiaries, MNEs are able to arbitrage national differences in comparative and competitive advantages, and to generate superior returns compared to domestic and non-specialized international competitors (see Asmussen, Pedersen, and Dhanaraj 2009). This argumentation follows rather recent literature that assumes the accumulation of specialized know-how in regionally limited centers of excellence.

Criticism against the capability-driven framework has questioned capability-seeking as the primary driver of internationalization and performance, seeing other neglected but relevant motives, such as market-, resource-, or efficiency-seeking internationalization (see Tallman and Fladmoe-Lindquist 2002). Nevertheless, the explicit consideration of learning and gaining access to new capabilities as motive for internationalization represents a valuable aspect when studying foreign R&D activities. Moreover, this strand enriches existing advantage categories with aspects of mutual learning on the sales and factor market.

The *eclectic paradigm* (Dunning 1977, 1979, 1980, 1988, 1993, 1995, 1998, 2000) can be considered as "the dominating, mainstream international business approach" (Rugman and Verbeke 2001, p.239). It merges different isolated theory strands and differentiates between three types of configuration parameters: contractual resource transfers, FDI, and exports. The configuration depends on the parameter of the ownership advantages, location advantages, and internalization advantages. These factors are often referred to by the acronym OLI, according to their three initial letters. Ownership advantages build on the monopolistic advantages theory and offer the company a competitive edge in the foreign market. For example, these advantages might arise from superior technology or size advantages. Their availability represents a necessary precondition for international activities of a company. Location advantages comprise the benefits from locating value creation activities in a host country. They might include superior factor quality and cost, concentration of knowledge, or cultural affinities. Internalization advantages occur if a company's internal coordination costs are lower than the market transaction costs. According to this view, a firm should choose FDI if all three advantages can be captured. However, if a host country does not provide sufficient location advantages, the firm is expected to opt for exports rather than FDI.

Despite its relevance in IB research, the eclectic paradigm has been subject to severe criticism. With regard to the subject under investigation in this study, some critiques are of particular importance: The advantage categories show interdependencies and overlaps (Andersen 1997; Itaki 1991; Malhotra, Ulgado, and Agarwal 2003), leading scholars to call the strand a "conglomeration of disconnected variables" (Perlitz 2000, p.129). Moreover, the internationalization strategies are incomplete (see Malhotra, Ulgado, and Agarwal 2003) and are based on a rather narrow perspective of FDI (see Axinn and Matthyssens 2001). Furthermore, the eclectic paradigm regards its three types of configuration as mutually exclusive and thus does not allow for mixed strategies. Neither does it explain the occurrence of different configuration strategies of a company in the same host country (Stehn 1992).

Despite these named limitations, the eclectic paradigm provides an integrative perspective of international configuration, and it and stresses the diversity of motives and sources of competitive advantage. Location advantages are regarded as a decisive factor to distinguish between different international configuration strategies within firm boundaries. Moreover, the present study aims to overcome major points of criticism that have been raised. Accordingly, the research framework of this study allows for mixed strategies and thus the free combination of different configurations. Moreover, to avoid redundancies, ownership and internalization advantages are not explicitly modelled. Whereas Dunning addresses the question of whether a company possesses enough competitive advantages for internationalization, this study focuses mainly on how to configure foreign R&D activities, and why.

There are further strands of internationalization theory that are applied in related research and that provide insights into the explanation of international R&D configuration. However, because of their rather partial contributions, the discussion of these strands is limited to certain key aspects.

The *learning theory of internationalization* (Johanson and Vahlne 1977, 1990, 2003) stresses path-dependency of internationalization. This strand is also referred to as the ”Uppsala internationalization model“, or the “establishment chain model“, or sometimes even as ”internationalization theory” (see Craig and Douglas 1996; Malhotra, Ulgado, and Agarwal 2003) . Similar to the IPLC theory, it provides evidence for the relevance of incremental differences in international configuration strategies. Based on the work of Cyert and March (1963) and Aharoni (1966), internationalization is considered to be an organizational learning process leading to a stepwise increase in foreign market commitment. Firms choose their international configuration according to their previously gained experience in the respective market. To minimize the risk associated with foreign activities, firms initially prefer exports. Only with increasing experience might they establish their own sales organization and later even locate other value creation activities, such as manufacturing and R&D. This strand argues that firms internationalize according to the psychic distance chain: They first expand

into countries with similar characteristics and culture before investing in and moving into countries with a higher psychic distance (see Evans and Mavondo 2002; O'Grady and Lane 1996). Criticism has been raised because of the partial character of this strand, noting that it considers knowledge as the only explanatory variable (see Andersen 1993). Moreover, learning theory of internationalization suffers from its rather deterministic character, leaving limited room for strategic managerial decisions with regard to internationalization decisions (Hedlund and Kverneland 1985; Reid 1983; Turnbull 1987). For purposes of this study, the contribution of the learning theory of internationalization is particularly its assumption of incremental differences and development stages in firms' international configuration strategies. Moreover, it stresses the importance of differences in home and host country characteristics in international expansion and in the location of value creation activities.

The *diamond model* by Porter (1990) argues that home country factors contribute to the international success of industries. Factor conditions, demand conditions, and characteristics of related and supporting industries, as well as firm strategy, structure, and rivalry determine the international competitiveness of a country. The model states that firms can derive location-specific competitive advantage from the presence of local industry clusters. According to Porter, MNEs that are based in industrial clusters in their home countries are highly competitive in the global marketplace, resulting in an increased export propensity from those clusters. However, in contrast to the cost advantage theory and the factor proportion theorem, the diamond model argues that an initial low factor endowment might also turn out to be beneficial in the long run because it forces companies to economize on scarce resources and thus drives innovation. Although this view has been criticized for its limited prescriptive value (Dunning 1993; Rugman and D'Cruz 1993), the diamond model offers valuable insights when studying internationalization of R&D. One contribution of the approach is the integration of firm, industry, and country level factors. The combination and interplay of these factors influence the configuration of value creation activities. The diamond model originally assumed that home country conditions drive the international configuration of value creation activities. Davis and Meyer (2004) therefore criticize the model for

not explicitly considering different location advantages as experienced by the subsidiary per se. This caveat from David and Meyer can be countered by analytically transferring the factors to a host country perspective. Correspondingly, some researchers have drawn upon aspects of the diamond model and investigated the influence of the subsidiary's environment on subsidiary roles and mandates (e.g., Almeida and Phene 2004; Cantwell and Mudambi 2005; Frost, Birkinshaw, and Ensign 2002; Mariotti and Piscitello 1995). This study takes a similar perspective, considering different host country diamond components as driving forces in the configuration of subsidiary R&D.

4 Research Framework and Hypotheses

Building on the identified research gap, the outlined research questions, and the discussed theoretical foundations, the task in this chapter is to define a set of explanatory variables that are expected to influence the subsidiary's R&D configuration strategy on an a priori basis, leading to the research framework that constitutes the basis for the empirical analysis of the study. The research framework contains the constructs and their relationships to each other (Kubicek 1975). After an explanation of the three dimensions of the framework (A, B, and C), the predictions on the relationships between the individual constructs are developed. Following the recommendations of Shah and Goldstein (2006), the hypotheses build on both theoretical considerations and prior empirical results, allowing a comprehensive specification of expected findings and avoiding causal misinterpretations. The chapter concludes with a summary of the hypotheses.

4.1 Research Framework

The research framework of this study builds on a contingency-based approach analyzing the interplay of contingency and response variables in the context of international R&D. The framework considers two dimensions of environmental variables: location-based features and industry-based features. Subsidiary R&D configuration strategies constitute the response variables.

Figure 3 provides an overview of the research framework and the research questions that were derived in the introductory chapter. The research questions are linked to the analysis of subsidiaries' R&D configuration strategies (research question 1) and to the relationships between the environmental factors and subsidiary R&D (research question 2):

> *1a. Which R&D configuration strategies do foreign subsidiaries in emerging countries pursue?*

1b. How do these strategies vary across different contexts and over time?

2a. How do location factors relate to the choice of international R&D configuration in emerging countries?

2b. How do industry factors relate to the choice of international R&D configuration in emerging countries?

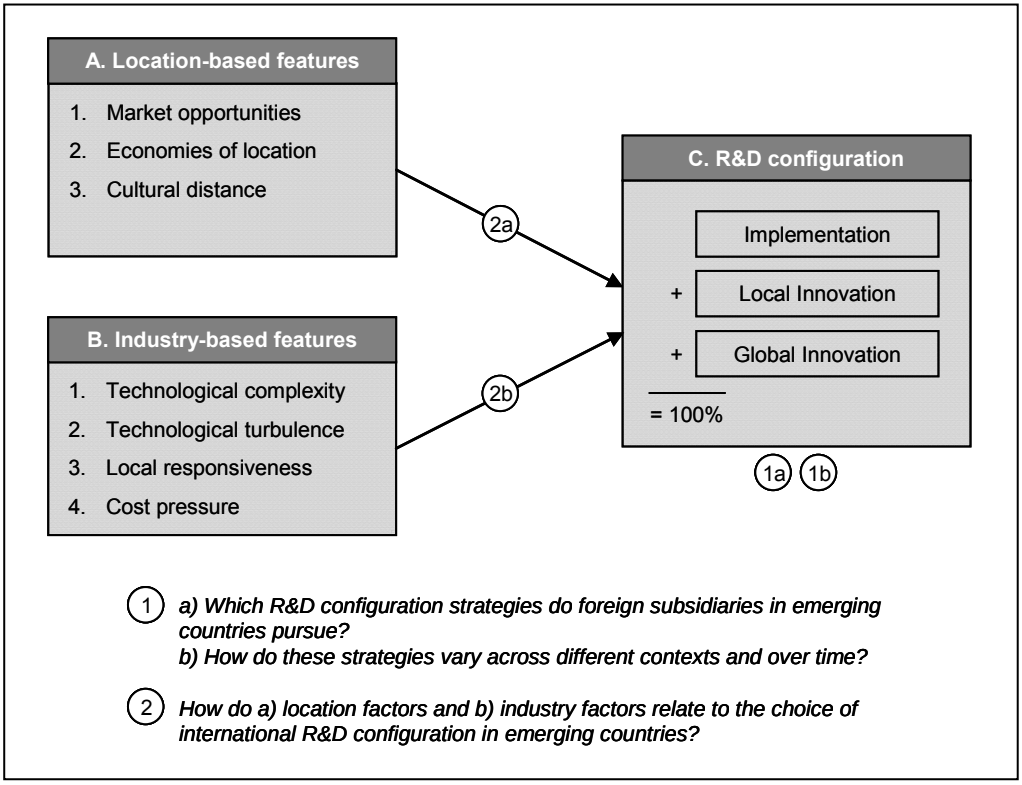


Figure 3: Research Framework

As described earlier, extant literature discusses a variety of single factors influencing international R&D. On a broader perspective, the location and integration of subsidiary R&D activities may be motivated by two sets of reasons: location-specific and in-

dustry sector-related factors. In the following section, variables are identified to capture the effect of these two factors.

4.1.1 Dimension A: Location-Based Features

Local environmental factors are a commonly investigated contingency of the internationalization of R&D (e.g., Cantwell and Iammarino 2000; Cantwell and Mudambi 2005; De Meyer and Mizushima 1989; Frost 2001; Hakanson and Nobel 1993a, 1993b; Hakanson and Zander 1988; Kuemmerle 1999a; Kumar 2000b, 2001; Le Bas and Sierra 2002; Odagiri and Yasuda 1996; Pearce and Singh 1992). Accordingly, literature cites "a range of putatively valuable location advantages" (Davis and Meyer 2004, p.360). However, most analyses of international R&D are on MNE incentives to internationalize R&D and thus are limited to MNE perspectives (i.e., on headquarters assessments of location-specific features). A comprehensive analysis of the interaction and relationship between local environmental factors and subsidiary R&D configuration remains to be made (see Kumar 2001). Based on extant theoretical and empirical work in the field, this study summarizes these host-country attributes using three motives that have been identified as being of special importance to a firm's configuration of its international R&D: market opportunities, economies of location, and cultural distance. The first two represent internationalization motives regarding the host countries' sales and factor markets, respectively, that MNEs can turn into a competitive advantage; the third one covers environmental differences between the home and host countries.

Market opportunities represent the benefits gained on foreign sales markets. Such benefits include demand-based sources of competitive advantage (e.g., market size and growth or the possibility of selling older technology in a less sophisticated market), as well as competition-based sources (e.g., low competition intensity and low threat of substitutes or attacks from foreign competitors in the home market).

Economies of location represent benefits gained on foreign factor markets – consider-

ing both factor costs and factor quality. Economies of location are comparative advantages of nations and have to be distinguished from competitive firm-specific advantages (Kogut 1985a). MNEs can turn the comparative advantages of a host country to their own competitive advantages by configuring their value-adding activities in such a way that each activity is located in the country that has the least cost for the factor that the activity uses most intensively, leading to the geographical fragmentation of the value chain (Bellak 2005; Dunning 1998; Ghoshal 1987; Porter 1986b).

Cultural distance describes differences in local contexts, which are expected to be an especially important constraint on the international configuration of value-adding activities (Cantwell 2009). Extant literature argues that cultural differences between home and host countries influence the costs and profitability of R&D projects (Hymer 1976; Zaheer 1995), as well as the use and success of international R&D projects by foreign affiliates (Ambos and Schlegelmilch 2004; Nakata and Sivakumar 1996; Zedtwitz and Gassmann 2002). Cultural distance has been found to influence internationalization of R&D (e.g., Granstrand 1999; Hakanson 1992). However, the relative strength of the influence compared to other factors has only rarely been assessed empirically (see Granstrand 1999).

Hence, dimension A of the framework covers MNEs' benefits from structural advantages of host countries, on the basis of both the sales market (output) and the factor market (input), as well as in terms of the cost associated with their exploitation.

4.1.2 Dimension B: Industry-Based Features

In addition to location-specific features, this study investigates the effect of industry-related characteristics on R&D configuration. The external environment, represented by the industry in which the firm competes, exerts pressures to which it must adapt to survive and prosper (Collis 1991; Teece, Pisano, and Shuen 1997). Based on this rationale, industry factors are expected to influence the international configuration of value creation activities (Gao et al. 2010). As most prior studies in the field of R&D

internationalization seem to focus solely on the country level determinants of R&D configuration, they neglect the possibility that competitive advantages might also be driven by industry level factors (see, e.g., Birkinshaw, Morrison, and Hulland 1995; Porter 1990). Cantwell and Mudambi (2005) point out that "R&D is a very industry-specific activity. The differences in strategies […] are highly industry specific" (p.1117). Also Ambos and Ambos (2009a) assert that industry-specific features "provide an important basis for R&D investments" (p.28). Similarly, Le Bas and Sierra (2002) require the consideration of industry characteristics when observing that "[t]he basis question which is raised by this analysis is: are there technological foundations to the foreign location of knowledge activities?" (p.589). Also Ketokivi and Ali-Yrkkö's (2009) results regarding the localization of R&D and manufacturing activities in Finnish MNEs prompt the consideration of industry factors. Nevertheless, the influence of industry-related factors on R&D internationalization has only rarely been subject to empirical investigations (see Hegde and Hicks 2008, p.391). Some studies addressing differences between industries (e.g., Ambos 2005; Edler 2004; Kumar 2001; Le Bas and Sierra 2002; Narula 2002; Patel and Pavitt 2000; Zedtwitz and Gassmann 2002) are merely descriptive rather than of confirmatory nature. Such an exploratory analysis is also part of this study, and the results are discussed in the context of research question 1b, addressing the variation of R&D configuration across different contexts and over time. In addition, this study analyzes how industry-specific factors influence subsidiary level R&D configuration. No extant literature was identified that focuses specifically on this question to guide the present study in making predictions. However, after an extensive review of the pertinent studies in the relevant fields, a set of industry-related factors was identified that are expected to favor or disfavor the location and cross-border integration of R&D activities in emerging countries. The following industry-specific features have been considered in the research framework: technological complexity, technological turbulence, the need for customization (local responsiveness), and cost pressure.

4.1.3 Dimension C: R&D Configuration

Dimension C of the research framework contains the independent variables. In the sense of contingency theory, R&D configuration thus represents the response variable of the firm to the environmental variables (see Zeithaml, Varandarajan, and Zeithaml 1988). The approach taken in this work (see Chapter 5.1.2 on the research object for a more detailed discussion) follows the recent stream of research that explores the strategies, roles, and mandates of individual subsidiaries in the MNE (see, e.g., Asmussen, Pedersen, and Dhanaraj 2009; Phene and Almeida 2008; for a systematic review see Manolopoulos 2008). As described in the definition of terms, literature often uses the terms “subsidiary strategy” and “subsidiary role” interchangeably (Birkinshaw and Morrison 1995). Because strategy suggests a higher degree of freedom at the subsidiary level, rather than a deterministic process, this study prefers the term “R&D strategy” when referring to the configuration of R&D activities.

The literature review revealed that extant studies have developed a variety of dimensions and taxonomies in the classification of international R&D, and a widely accepted standard has not been developed. Moreover, literature on internationalization of R&D appears as a rather independent field. Although different characteristics have been applied to discriminate between different types of international R&D (e.g., nature of activity, geographic scope, linkages to other units, and mode of formation), there is at least some consistency in the proposed roles and strategies (see Nobel and Birkinshaw 1998). This study thus aims for a comprehensive but parsimonious mapping of subsidiaryies’ R&D configurations using measurable and action-oriented strategy dimensions. Building on the discussed strands of FDI, trade, and IB theory, subsidiary R&D strategies are defined along two independent dimensions, as proposed by the influential contribution of Jarillo and Martinez (1990). The first dimension is the degree of localization that indicates whether and to what extent foreign affiliates perform certain value-creating activities, such as R&D. The degree of localization can be regarded as a proxy for subsidiaries' embeddedness in the local environment (see Manolopoulos 2008). Because localization is closely related to FDI, this dimension is

largely based on FDI theory, explaining when to localize value activities abroad. The second dimension is the degree of integration, covering whether and to what extent those activities are linked to other parts of the global MNE network. This dimension corresponds to the degree of resource interdependencies between the subsidiary and other locations. Because the integration of value creation across borders is closely related to exports and imports, this dimension largely refers to trade theory. International business theory is related to both the localization and the integration dimensions. Overall, the two dimensions of the framework represent the main decision variables pertaining to the architecture of firms' value creation systems (see Kaufmann and Jentzsch 2006, p.55).

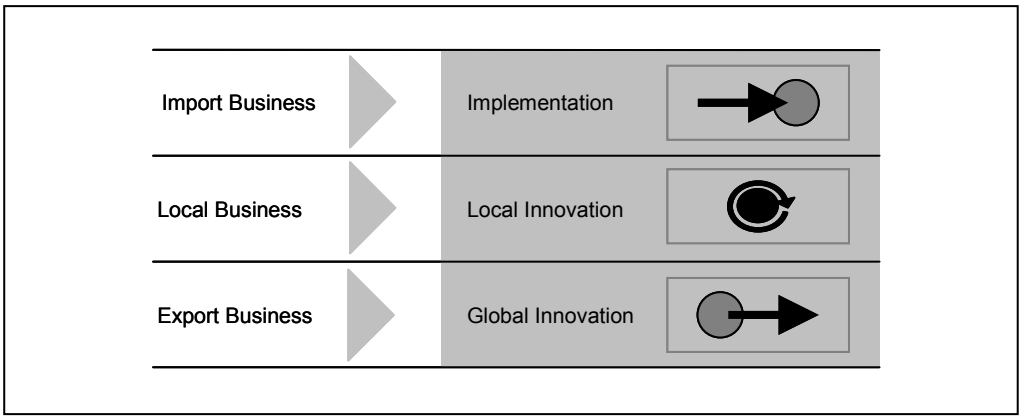


Figure 4: Major Subsidiary Strategies and R&D Configurations

On the basis of the combination of the localization and integration dimensions, we can distinguish among three archetype subsidiary strategies: import business, local business, and export business. Jarillo and Martinez (1990) denote the corresponding roles: receptive, autonomous, and active. The attempt to integrate the current literature on international R&D with the discussed international business theory results in three basic R&D configurations. To avoid confusion with existing typologies that are based on a different measurement and to ensure consistency with the applied opera-

tionalization, the configuration strategies are labeled Implementation, Local Innovation, and Global Innovation, respectively (see Figure 4).

The first strategy, *Implementation*, is defined as an international R&D configuration characterized by a low degree of localization but a high degree of integration. Technological expertise and know-how, as well as R&D output, such as product development and process design, are mainly ”imported” from other parts of the MNE network (see Gupta and Govindarajan 1991). This type of R&D unit primarily supports the sales and production activities in the host countries by adapting products developed in other R&D laboratories to the need and taste of the respective local market. These R&D units also might facilitate the transfer and application of product and process technologies that are already established within the company (Medcof 1997) – for example, by providing some technical support and service to the dealers or users (Odagiri and Yasuda 1996).

This strategy corresponds to what Ronstadt (1978) has labeled “technology transfer unit” and Pearce (1989) has called “support laboratory”. The activity of these units is based on technology supplied by the multinational parent, and they are established to support the transfer of manufacturing technology to a foreign subsidiary while also providing related technical services for foreign customers (p.8). Medcof (1997) further differentiated this technical support function by distinguishing between “marketing support units” and “manufacturing support units”. Hewitt (1980) labeled the corresponding type as “product adaptive R&D“, which relates to adapting parent technology to the host country market. Chiesa (1996a) called it “adaptation R&D and technical support lab“, and Nobel and Birkinshaw (1998) suggested “local adopter” to describe R&D units that “are always local in scope, and with a rather limited development mandate” (p.481). Implementation also reflects the “support laboratory” (SL) and the “traditional support laboratory” (SL1) proposed by Hood and Young (1982); Pearce (1989; 1999; 2005); Pearce and Singh (1992); Pearce and Papanastassiou (1999); Papanastassiou and Pearce (1999; 2005); Manolopoulos, Papanastassiou, and Pearce (2005; 2007). This unit’s task is to “help the associated production sub-

sidiary to operate to the fullest potential of the imported technology" (Papanastassiou and Pearce 2005, p.91) and thus to facilitate inward technology transfer (Manolopoulos, Papanastassiou, and Pearce 2007). As such, these units are mainly involved in the technological adaptation of existing goods rather than the development of new products or processes (Papanastassiou and Pearce 1994b). Kuemmerle's (1997; 1999a; 1999b) "home-base exploiting" (HBE) sites also loosely match this type. These sites "support the transfer of knowledge and prototypes from the firm's home location to actual manufacturing" (Lewin, Massini, and Peeters 2009, p.904) and thus are driven by capability-exploiting motives.

Considering the degree and direction of integration, this strategy also corresponds to Gupta and Govindarajan's (1991; 1994) "implementer", although their typology refers to the subsidiary as a whole and not solely its R&D activities. This type engages in very little knowledge development; instead, the unit receives its knowledge from headquarters or other subsidiaries.

The theoretical foundation of Implementation configuration is mainly described in trade theory; it is this strand that explains the cross-border integration of value creation. The cost advantage theory, the factor proportion theorem, and the technological gap theory thereby emphasize asymmetry, in terms of both supply condition and technological capabilities, as the motive for exports in cases where conditions for performing R&D activities are more favorable outside the subsidiary's host country. Demand structure hypothesis argues that similar customer preferences allow the MNE to benefit from economies of scale resulting from volume bundling across countries.

The Implementation strategy is also entirely consistent within the IPLC model by Vernon, which favors centralization of R&D activities when a firm's innovational lead is created in its home country and then rolled out and adapted to foreign markets. The eclectic paradigm proposes Implementation in cases where ownership and internalization advantages exist and location advantages are absent. From the perspective of learning theory, Implementation allows firms to gain experience in new foreign mar-

kets with a limited resource commitment.

The second strategy, *Local Innovation*, is characterized by a high degree of localization but a low degree of cross-border integration of R&D activities. The degree of Local Innovation represents the value creation provided by the local R&D unit for its own subsidiary. This unit is dedicated to developing products for the local market and works in association with other functions of the subsidiary, such as marketing, engineering, procurement, and production, but acts rather independently in terms of inputs from other members of the group. This strategy corresponds to Pearce and Papanastassiou's LIL, providing support for a local production facility in the development of new products that, compared to the Implementation, "will then much more decisively encompass the local subsidiary's perspective on both the needs of the market they will supply and the conditions under which the good will be manufactured" (Pearce and Papanastassiou 1999, p.24). This unit has a substantially broader scope and plays a more fundamentally creative role, aspiring to endow its subsidiary "with some kind of product autonomy" (Pearce 1991, p.14) . Bartlett and Ghoshal (1990) argue that such "local-for-local innovations are essential for responsiveness to the unique attributes of each of the different national environments. […] But, on the negative side, such innovations may also reflect the efforts of national subsidiaries to differentiate themselves to retain their identity and autonomy" (p.220 et seq.). Other corresponding terminologies are ITU by Ronstadt (1978), which has responsibility for developing "new and improved products expressly for foreign markets [that] were not the direct result of new technology supplied by the parent organizations" (p.9), and also to a certain degree Hakanson and Nobel's (1993a; 1993b) "production support R&D", in which the units work independently with only weak ties to the rest of the MNE network.

As noted by Pearce (1991), units following the Local Innovation strategy were traditionally attached to locally focused manufacturing sites, whose responsibility was exclusively to the domestic market. However, with increasing globalization of manufacturing, production sites increasingly hold regional or global mandates, so R&D re-

sponsibilities are likewise international in scope (Hakanson and Nobel 1993b). Nobel and Birkinshaw (1998, p.482) thus assume this type of laboratory to be in a transitional state, moving toward increased product autonomy, with the implication being that these units could potentially offer technological enhancements to other entities within the MNE. They reflect the corresponding broader role of subsidiary R&D in what they call “international adopter“. With the above-mentioned restraints, the strategy of Local Innovation reflects Gupta and Govindarajan’s (1991; 1994) “local innovator”, which is characterized by very little knowledge inflow or outflow. Instead, this unit creates knowledge that is idiosyncratic to its specific host country environment and is of limited value elsewhere.

The theoretical foundation can be derived from strands of FDI and IB theory. Monopolistic advantage theory, for example, argues that companies can exploit firm-specific advantages abroad by localizing value-creation activities. The trade barrier approach supports Local Innovation to circumvent substantial trade barriers. Oligopolisitic parallel behavior theory argues on the basis of competitive strategy and expects MNEs to localize value creation in low-cost countries to compensate for a disruption of the oligopolistic equilibrium on the home market because of investments of firms originating from emerging countries (see Kaufmann and Körte 2010). The diamond approach highlights the importance of country characteristics for the location of value creation activities, and the eclectic paradigm suggests Local Innovation in cases where ownership, internalization, and location advantages are given. Because the same suggestion holds for all strategies with a high degree of localization (i.e., also for Global Innovation), the eclectic paradigm does not allow for differentiation between the Local Innovation and the Global Innovation strategy. Favorable demand and factor conditions may foster Local Innovation. Learning theory of internationalization argues on the basis of the establishment and psychic distance chain and suggests Local Innovation only in cases of prior experience in the market and for host countries with low psychic distance. Similarly, internalization theory proposes avoiding Local Innovation in cases where control and governance costs (e.g., communication costs to overcome linguistic and cultural barriers) are comparatively high.

Finally, *Global Innovation* is characterized by a high degree of localization and a high degree of cross-border integration. The basic idea of this resource- and efficiency-seeking strategy corresponds to globally distributed, interdependent, value-creation activities and thus to a global network of interrelated subsidiaries. Activities are located in the location that offers the best set of relevant factor conditions, while international linkages allow for the bundling of activities across countries and thus for the company to realize economies of scale. From a theoretical perspective, this strategy represents a departure from the "traditional" assumptions of the IPLC and a movement toward more recent streams of IB literature recognizing that MNEs do not merely apply or adopt centrally generated knowledge in foreign operations. Rather, subsidiaries have contributing or leading roles in product innovation and consequently enhance the innovative capabilities of the whole MNE network (Almeida and Phene 2004; Bartlett and Ghoshal 1989; Cantwell and Janne 1999; Chung and Alcácer 2002; Florida 1997; Hedlund 1986; Wesson 1993; Zanfei 2000). These units typically are leaders in their area of expertise, often located specifically to tap into a particular geographically limited center of technological excellence (Bartlett and Ghoshal 1986; Cantwell 1991; Frost, Birkinshaw, and Ensign 2002; Porter 1990). This role is reflected in Kuemmerle's (1997; 1999a; 1999b) HBA R&D site, as well as in the strategic asset-seeking R&D of Dunning and Narula (1995). With such R&D activities, MNEs want not only to gain access to foreign immobile technological resources and assets, but also to benefit from spillovers resulting from externalities created by local institutions and firms (Almeida and Phene 2004; Feinberg and Gupta 2004; Kuemmerle 1999a). Such foreign R&D units build on their absorptive capacity (Cohen and Levinthal 1990, 1994) to augment the firm's existing stock of knowledge and to acquire or monitor complementary competitive advantages (Le Bas and Sierra 2002; Phene and Almeida 2008).

Yet we should recognize that, already, earlier typologies accounted for similar roles. Ronstadt (1977) suggested GTU and CTU; the former is mainly oriented toward the development of new products and processes for simultaneous application in major world markets of the MNE, and the latter is more oriented toward the generation of

new technology and long-term research. Similarly, Hakanson and Nobel (1993a) proposed two fairly corresponding types: the “research unit” and the “generic R&D unit”. While the former is very similar to the CTU of Ronstadt and oriented more towards development, the latter represents something of a hybrid form between development and research (see Nobel and Birkinshaw 1998, p.482). Considering its integration into the MNE network, the Global Innovation strategy also encompasses what Hakanson and Nobel call “monitor research”. These units are established to monitor the technological development in the host country and might also recruit highly specialized technical expertise that is not available in the home country.

The corresponding strategy to Global Innovation by Hood and Young (1982) and Pearce (1989) is the “international interdependent laboratory”, and by Pearce and Papanastassiou (1999) is the “internationally integrated laboratory” (IIL). In these strategies, the lab is interdependent, working with similar labs in other countries “to pursue the regeneration of the group’s core technologies” (Papanastassiou and Pearce 2005, p.94); however, there is not necessary a connection with other functions in the host country that are related to the competitiveness of current products and technologies. In addition to this rather basic research-oriented unit, this configuration also encompasses what Pearce and Papanastassiou (1999) call the SL2 unit. This role is an extension of the traditional support laboratory in that the unit is involved in development activities, although with the output’s being for international use. This local R&D unit provides advice on the adaptation of existing technologies and/or the development of new technolgies to other manufacturing subsidiaries in the global MNE network. The underlying rationale can be either cost-efficiency or a subsidiary’s product mandate, with a move toward both concentration of technological know-how and internationally integrated supply networks, as individual subsidiaries take on specialized responsibility for particular product groups. Such an R&D facility thus possesses “distinctive knowledge and competencies that can be shared in beneficial ways with other parts of the parent MNE group” (Manolopoulos, Papanastassiou, and Pearce 2007, p.665). Nobel and Birkinshaw (1998) call their counterpart to Global Innovation an “international creator” and point out two distinguishing character-

istics: First, the activities of the site comprise research and development, rather than improvement and adaptation responsibilities. Second, this site is primarily linked to corporate and divisional R&D, not local manufacturing.

Being characterized by strong interdependencies with other locations of the MNE, the Global Innovation strategy relates to the “global innovator” and “integrated player”, in the terminology of Gupta and Govindarajan. While the global innovator mainly provides input for other units of the company network, the integrated player additionally builds on input from the rest of the MNE and thus shows bi-directional interdependencies. The underlying dimensions of the configuration applied in this study consider cross-border integration as one dimension and do not differentiate between inbound and outbound knowledge flows and technology transfer.

The theoretical foundation of the Global Innovation strategy covers both localization and integration of value-adding activities and thus comprises strands from FDI, trade, and IB theory. Monopolistic advantage theory considers internationalization to be the result of a firm’s monopolistic advantages, such as patented or superior technological know-how or economies of scale. Although scale effects might arise from bundling of activities across countries, firms at the same time have to overcome barriers to international operations, such as cultural differences. In cases where the associated costs outweigh the benefits, Global Innovation might not be a reasonable strategy. Internalization theory comes to a similar conclusion and suggests that this strategy is applicable in cases where sufficiently low coordination costs arise (e.g., from effective and efficient communication across cultures). Cost advantages theory and factor proportion theorem attribute localization of R&D and subsequent integration to favorable factor endowments resulting from a low cost or high qualification level. The demand structure hypothesis argues that similar customer preferences across countries allow R&D units to specialize, taking international responsibility for certain products or technologies. The diamond approach emphasizes the importance of country factor conditions, such as workforce qualification, externalities from clusters, supporting industries, and the competitive environment. The capability-driven framework of inter-

nationalization would suggest that the Global Innovation strategy is the result of an international dispersion of specific knowledge. The strategy allows the firm to gain new capabilities and to internalize and integrate them into the company's global network structure. In doing so, the MNE might benefit from leveraging locally embedded technological know-how as a source of competitive ownership advantage. This perspective is consistent with the evolutionary theory, which establishes Global Innovation in terms of accessing, transferring, and combining locationally dispersed knowledge (see Chapter 3.3).

Nobel and Birkinshaw (1998) notice that "several factors make the generation of a meaningful [R&D] typology difficult" (p.486) and refer to two major issues: First, it is known that roles change over time, and so the boundaries between the different typologies are ambiguous and not mutually exclusive, as assumed (Pearce 1989). And second, a single unit can easily pursue more than one strategy at a time.

Whereas most prior typologies classify R&D units in one specific category (see Chapter 2.3) and mainly apply some kind of heuristics to identify the type of strategy (see Nobel and Birkinshaw 1998), the suggested research framework for purposes of this work allows for what we call "mixed strategies" (i.e., the coexistence of different strategies within the same subsidiary). Accordingly, the R&D configuration of the subsidiary represents a combination of each of the three strategies, with varying degrees of each, so that gradual differences between R&D units, as well as developments and changes over time, can be measured.

Summarizing this section, we differentiate R&D configurations on the basis of two independent dimensions derived from IB theory. The resulting three strategies exhibit clear characteristics and theoretical foundations. The introduced configuration allows for the mapping of extant R&D typologies; yet, it has to be noted that in some cases there are certainly somewhat fuzzy boundaries because of the variety of dimensions on which the different typologies are based. This lack of clear distinction particularly holds for hybrid roles, such as Hakanson and Nobel's (1993a; 1993b) multi-motive

unit, as well as for typologies that distinguish between the types of technical work being done (e.g., Medcof 1997; Zedtwitz and Gassmann 2002). Given the state of knowledge and considering the research goal of the study, the R&D configuration presented represents a meaningful foundation for further analysis.

4.2 Hypotheses

In this section, the hypotheses regarding the relationships between the subsidiary R&D configuration and both location- and industry-based features are developed. They are derived from extant literature on multinational R&D, subsidiary roles, and international configuration. The study analyzes the degree to which specific location- and industry-related factors determine the configuration of subsidiary R&D activities.

4.2.1 Location-Based Features

Addressing research question 2a, the expected relationships between location factors (dimension A of the research framework) and R&D configuration in emerging countries (dimension C of the research framework) are developed. Hence, the expected connections with market opportunities, economies of location, and cultural distance are discussed, successively, in the following sections.

Market Opportunities

As described, international R&D traditionally has been understood as supporting foreign markets and thus aims to exploit market opportunities abroad (Casson and Singh 1993). As demand from customers becomes increasingly sophisticated, local R&D activities are useful in helping the firm to adapt existing products or processes to local needs (e.g., Bartlett and Ghoshal 1990; Hakanson 1990). Basically, there are two different options for exploiting market opportunities: through centralized R&D and cross-border exchange or through localization of R&D targeted to developing specific

products for sale in the respective country. Consequently, different theories suggest how firms can benefit from market opportunities abroad.

Major trade theory strands assume local demand-side market opportunities as the primary motive for exports from the home country to the respective host country. According to the technology gap theory, for instance, cross-border exchange results from differences in the state of technological development between countries. The necessary highly skilled engineers and technological know-how might not be available locally in the host country, preventing the localization of R&D activities to serve local demand. This aspect of the market support function is most apparent in the IPLC model (see Ambos 2005, p.402; Hegde and Hicks 2008, p.391), which suggests that MNEs keep all sophisticated R&D activities in the home country, close to headquarters. Foreign subsidiaries, if they are engaged in R&D at all, only adapt existing products or processes to specific local requirements. Hence, they show only a small degree of local R&D activities, implying a positive relationship between market opportunities and Implementation strategy. Emphasizing the protection of a firm's knowledge when penetrating foreign markets, internalization theory also argues that subsidiary R&D is limited to a supportive function, with only little local value creation (Penner-Hahn 1998; Rugman 1981a).

A considerable part of FDI literature argues that localization occurs when firms aim to exploit firm-specific advantages in foreign environments. Traditionally, most FDI in manufacturing and marketing is consistent with this category (see Lewin, Massini, and Peeters 2009, p.904). For R&D activities, this relationship is often described as a home-base exploiting motive (Kuemmerle 1999a, 1999b), or asset-exploiting FDI (Dunning and Narula 1995). Thus, theoretical considerations also suggest a positive relationship between market opportunities and localization of innovation activities. The monopolistic advantage theory, for example, considers competition-related aspects of market opportunities that allow firms to exploit ownership advantages against weaker foreign competitors. The oligopolistic parallel behavior theory suggests Local Innovation for following the leader into a new country, for cross-investments, or for

gaining first-mover advantages in foreign market penetration. The capability perspective argues that localization occurs when firms seek to exploit existing capabilities. With increasingly sophisticated demand, local R&D activities are useful in helping a firm to better adapt existing products to local needs.

Empirical support for the market support function of R&D is found in diverse types of R&D strategies and roles, discussed in extant literature such as inter alia Ronstadt's (1978) technology transfer unit, Pearce's (1989) support laboratory, and Papanastassiou and Pearce's (1999) traditional support laboratory (see also Chapter 4.1.3). Previous empirical findings support a positive relationship between market opportunities and both Implementation and Local Innovation. Scholars like Teece (1977), Lall (1979), Patel and Pavitt (1991), and Caves (1996) found empirical evidence that MNEs tend to keep major R&D activities in their home country. In particular, early stage innovation is achieved by remaining close to headquarters. Foreign R&D activities tend to focus on minor adaptations for the respective market or less significant developments at a later stage of the lifecycle, or they might expand as foreign subsidiaries become more deeply integrated into local markets (Dalton and Serapio 1995; Hegde and Hicks 2008). Investigating international technological activities of MNEs in the 1980s, Patel and Pavitt (1992) concluded that, compared to manufacturing, R&D represents "an important case of non-globalization" (p.1). The main reasons for the high degree of centralization of R&D activities traditionally cited in literature are economies of scale, control of core technologies, and the risk of proprietary knowledge leaks, as well as coordination and communication issues (see, e.g., Ambos and Ambos 2009a; Granstrand, Hakanson, and Sjölander 1992; Kumar 2001; Pearce 1989; Zedtwitz and Gassmann 2002). Mansfield, Teece, and Romeo (1979) and Hirschey and Caves (1981) found a negative relationship between foreign R&D localization and exports from the parent company to the foreign subsidiaries. They concluded from the results that serving foreign markets by importing products from the home country (as opposed to serving them through local manufacturing) makes concentrating R&D activities in the home country, close to headquarters, more advantageous for the MNE. However, some of the necessary location-specific adaptations

might be “best undertaken closer to the markets for which they are meant” (Kumar 2001, p.164). Market opportunities justify the high up-front investments and operating expenses of host country R&D sites that adapt products to local demand (Kuemmerle 1999a). Studies found that sales market-related aspects have a positive influence on the internationalization of R&D (Enright 2009; Hakanson 1992; Hirschey and Caves 1981; Kumar 1996, 2001; Lall 1979; Mansfield, Teece, and Romeo 1979; Zejan 1990). In addition, Kumar (2001) showed that the localization of U.S. and Japanese R&D activities is positively related to the importance of market opportunities. He observed that a considerable amount of foreign R&D activities are intended to adapt or customize product and/or process technologies to specific local needs. In such cases, some R&D activities might be located in close proximity to local demand and manufacturing operations (Kuemmerle 1999a). Different scholars have described the importance of such a location decision (Clark and Fujimoto 1991; Fors 1997; Hayes and Wheelwright 1988; Howells 1990a, 1990b; Nonaka and Takeuchi 1995). Similarly, Pearce and Singh (1992) and Casson and Singh (1993) observed a positive relationship between the degree of localization of manufacturing and the degree of localization of R&D activities. (For a more detailed discussion, see Patel and Pavitt 1992). Manolopoulos, Papanastassiou, and Pearce (2007) found that R&D as local support function represents the most influential motivation for R&D activities in peripheral economies, “confirming […] the persistence of traditional support for technology transfer and adaptation in MNEs’ [foreign] subsidiaries” (p.677).

In contrast to Implementation and Local Innovation, the Global Innovation strategy does not target the host market. Rather, it focuses on the transfer and use of the outcomes resulting from local R&D activities to and in other parts of the company network. Although as a result no direct relationship is apparent between market opportunities and Global Innovation, there are substitutive effects that suggest a negative relationship. Papanastassiou and Pearce (1994a) found that host country market opportunities diminish an export orientation in foreign subsidiaries. Regarding FDI in R&D, the study of Kuemmerle (1999a) revealed a negative relationship between market opportunities and R&D activities that is unrelated to the respective host country.

Accordingly, as the importance of the local sales market increases, subsidiaries value creation activities that are more likely targeted to serve the needs of the local market, at the expense of work being performed for other markets.

The discussion thus leaves us with the following hypothesis:

Hypothesis 1: *Market opportunities positively affect Implementation and Local Innovation at the cost of Global Innovation.*

Economies of Location

The consensus seems to be that international R&D investments mainly have two different primary purposes: either to support foreign sales activities and apply the firm's existing knowledge or to access new resources and generate new knowledge (e.g., Almeida 1996; Cantwell and Mudambi 2005; Dunning and Lundan 2009; Kuemmerle 1997; Le Bas and Sierra 2002; Narula and Zanfei 2005; Niosi 1999). Countries vary in their innovation systems, including on such factors as the local pool of scientists, local science communities, education system, and sources of R&D funding (Edquist 1997; Lundvall 1992; Nelson 1993). Firms may localize R&D activities abroad with the aim of contributing to company-wide innovation by taking advantage of local supply-side factors and enhancing firms' existing technological capabilities (Iwasa and Odagiri 2004). In other words, the location can represent a source of competitive advantage (Cantwell and Janne 1999; Nachum and Zaheer 2005; Nohria and Ghoshal 1997; Porter 2000).

Chung and Yeaple (2008) identify two commonly cited explanations for firms' interest in following a capability- or technology-seeking strategy abroad: On the one hand, the firm's home country may lag behind in developing a new technology in a certain field; thus, the localization and cross-border integration of R&D activities abroad provides access to the stock of knowledge in the host country, suggesting that MNEs will follow an international knowledge-sourcing strategy in order to "catch up" (Cantwell 1989; Kuemmerle 1999a). On the other hand, a firm might localize and integrate value crea-

tion activities abroad to access and combine different types of knowledge and thus to obtain technical diversity (Cantwell and Janne 1999; Cantwell and Vertova 2004; Chung and Alcácer 2002). In doing so, firms are seeking “a greater potential to benefit from a synergistic locational portfolio of complementary sources of knowledge” (Cantwell 2009, p.35).

Although the number of qualified R&D personnel in emerging economies might look small in relative terms, compared to the labor markets in the triad countries, the picture turns out to look different in absolute numbers. In China, for example, the proportion of the population with a university degree is small; yet in absolute terms, the number of graduates from tertiary education is comparable to those in the United States and Europe (see OECD 2008a). Moreover, India has been regarded as the country with the highest availability of engineers (Morgan Stanley 2004). Nevertheless, surveys also indicate that only a small proportion of potential talent in emerging economies has the skills necessary to work at a MNE (Farrell and Grant 2005; Wince-Smith 2007).

The strategies of Local Innovation and Global Innovation are both characterized by localization of R&D activities and thus allow the subsidiary to benefit from economies of location, be it higher factor quality or lower factor costs (Kogut 1985a). While the former strategy targets the local market, the latter strategy’s R&D unit is characterized by cross-border integration. This orientation allows the firm to exploit comparative factor advantages of the host country in other locations (Foss and Pedersen 2002; Kogut and Zander 1993; Tsai 2001). In doing so, the MNE might benefit from cross-border knowledge and technology transfer, whether lateral (i.e., between subsidiaries) (e.g., Ghoshal, Korine, and Szulanski 1994; Nohria and Ghoshal 1997; Noorderhaven and Harzing 2009) or hierarchical (i.e., between subsidiaries and headquarters) (e.g., Ambos, Ambos, and Schlegelmilch 2006; Hakanson and Nobel 2000, 2001). In contrast to the Global Innovation strategy, the Local Innovation strategy cannot provide such an ”arbitrage function” (Ghemawat 2003, 2007). The potential benefit from advantageous factor conditions is limited to the host market and thus does not provide

competitive advantage over local host country competitors. This assertion is consistent with previous observations asserting that subsidiary-level innovation in contemporary MNEs is essentially a process of creative interdependencies between subsidiaries that request and share their own expertise with other parts of their MNE group (see Manolopoulos, Papanastassiou, and Pearce 2007, p.666). Thus, economies of location are expected to favor a Global Innovation strategy over a Local Innovation strategy. In the case of the Implementation strategy, major R&D activities are performed outside the host country, and only minor activities of relatively little importance relative to the value creation by other parts of the MNE network may be located in the host country. Because Implementation does not allow the firm to exploit local factor advantages, negative substitution effects are expected between economies of location and this strategy.

Several foundational theories deal with the question of how to exploit economies of location. According to the Ricardian cost advantage theory and the factor proportion theorem, countries specialize in those activities in which they possess a comparative advantage. Consequently, the availability of abundant qualified R&D personnel or other resources required for technical and innovation activities at a relatively lower cost or higher quality than in the home country might drive MNEs to locate part of their R&D activities to such locations (Ambos and Ambos 2009a; Kumar 2001). The diamond approach stresses the importance of, among other issues, local factor conditions, supporting industries, and government incentives as sources of competitive advantage. The eclectic paradigm also proposes localization of R&D activities in cases where host country factor advantages are found, such as labor costs, quality and productivity. Where location advantages are absent, this view proposes (given the existence of ownership and internalization advantages) Implementation as the favorable strategy. The capability-based theories emphasize the importance of economies of location for knowledge acquisition, learning, and competence development (Almeida 1996; Boutellier, Gassmann, and Zedtwitz 2008; Davis and Meyer 2004; Frost 2001; Patel and Vega 1999; Shan and Song 1997). According to this view, MNEs build up new knowledge by learning in foreign environments and ex-

change it within the global company network as a basis for competitive advantage (Gupta and Govindarajan 1991, 1994, 2000). Localization of value creation is required to access geographically bounded technological knowledge and capabilities (Almeida and Kogut 1999; Almeida and Phene 2004; Jaffe, Trajtenberg, and Henderson 1993; Porter 1990, 1998) and to tap into local clusters, "pockets of knowledge", or "centers of excellence" (Asakawa 2001b; Asmussen, Pedersen, and Dhanaraj 2009; Birkinshaw and Hood 2000; Chiesa 1996a). External linkages of the subsidiary and its embeddedness within its own local network (Andersson and Forsgren 2000; Driffield, Love, and Menghinello 2010) are considered critical in absorbing, combining, and internationally dispersing new technical and market knowledge and as crucial to the success of R&D (Ambos and Reitsperger 2004; Andersson and Forsgren 2000; Andersson, Forsgren, and Holm 2001, 2002; Hakanson and Nobel 2001; Phene and Almeida 2003; Zander and Sölvell 2000). Such external and internal linkages allow the subsidiary to generate distinctive capabilities and to create a sustained competitive advantage for the whole MNE (Birkinshaw, Nobel, and Ridderstrale 2002, 2008; Manolopoulos, Papanastassiou, and Pearce 2005). Considering the MNE as a knowledge-integrating institution based on knowledge flows and capabilities from differentiated locations (Cantwell 2009), evolutionary theory also underlines the internationalization of R&D activities for knowledge sourcing and for developing new capabilities (Chung and Yeaple 2008; Shan and Song 1997). In particular, country-specific technological advantages (Kogut 1990) and attractive national innovation systems (Chen 2007) might motivate firms to localize R&D activities in a certain location.

Prior research provides ample conceptual and empirical insights for the expected interrelation between location advantages and R&D strategies. Although the majority of the earlier work emphasized a subsidiary's ability to "push" existing advantages of the MNE in adapting centrally developed products to local market needs, more recent literature on multinational R&D has made considerable progress and underscores the importance of economies of location for knowledge acquisition, learning, and competence development (see Davis and Meyer 2004; Dunning 2009; Dunning and Lundan 2009; Hegde and Hicks 2008). Because of different factor endowments, countries

differ in their ability to attract international R&D (Cantwell 1989; Hakanson 1992; Patel and Pavitt 1995; Porter and Sölvell 1998). Several scholars (e.g., Ambos 2005; Cantwell 1991; Dunning 1993; Florida 1997; Kuemmerle 1999a) suggest an increasing effort by MNEs to access and develop new technologies abroad, leading firms to establish vast global networks that access technologies from various locations (Bartlett and Ghoshal 1989). Accordingly, a number of studies (e.g., Almeida, Song, and Grant 2002; Ambos, Ambos, and Schlegelmilch 2006; Papanastassiou and Pearce 1997; Shan and Song 1997; Singh 2007; Song and Shin 2008) have investigated how MNEs use FDI to "pull new resources and capabilities from centers of innovation by acquiring or learning about complementary technology" (Song and Shin 2008, p.292). Empirically, the notion of such resource-driven R&D internationalization is well reflected in the different types of R&D strategies and roles developed in literature, including Ronstadt's (1978) GTU, Hakanson and Nobel's (1993a) research unit, Dunning and Narula's (1995) strategic asset-seeking R&D, Shan and Song's (1997) technology-seeking FDI in R&D, and Kuemmerle's (1999a; 1999b) HBA FDI in R&D (see also Chapter 4.1.3). These strategies and roles are mainly characterized by the incorporation of technological and idiosyncratic factors arising from the environment of the host country and the subsidiary (see Manolopoulos et al. 2009, p.47).

Empirical findings indicate that the quality of factor endowments, such as availability of technology and access to technical talents, represents an important motivation for localization of R&D activities, particularly in triad countries (e.g., Florida 1997; Florida and Kenney 1994; Frost, Birkinshaw, and Ensign 2002; Furman, Porter, and Stern 2002; Iwasa and Odagiri 2004; Kuemmerle 1999a; Odagiri and Yasuda 1996). Granstand's (1999) survey of Japanese MNEs revealed that the factor, "creating access to foreign science and technology", was more highly rated as a driving force for the localization of R&D activities by Japanese firms than such market-oriented factors as "supporting local production" and "supporting local customers and markets". Kumar (2001) concludes that "[t]he relative success of smaller countries like Singapore and Israel in attracting R&D investments from MNEs is to be explained in their other advantages, viz., availability of trained labor and domestic technological effort, rather

than the market size" (p.167). Hegde and Hicks (2008) could recently show for U.S. MNEs that in addition to market opportunities, the science and engineering capability of a country is strongly correlated with the conduct of foreign R&D activities. For foreign subsidiaries in European countries, Davis and Meyer (2004) could confirm that a country's scientific institutions have a strong effect on the incidence and level of subsidiary R&D. Further empirical evidence on the technology-sourcing motive for the localization of R&D activities abroad comes from literature measuring technology transfer in terms of patent citations. The studies of Almeida (1996), Frost (2001), and Branstetter (2006) find that proximity to the local environment and sources of innovation matter because foreign subsidiaries cite firms that are located in geographical proximity significantly more often.

Regarding cross-border integration of foreign R&D activities, Sanna-Randaccio and Veugelers (2007) showed that efficiency in reverse intra-company technology transfer represents a critical factor for MNEs in benefiting from technology sourcing abroad. Ambos, Ambos, and Schlegelmilch (2006) found a positive relationship between host country location factors and knowledge transfer to headquarters. Singh's (2007) patent citation analysis revealed an increasing flow of knowledge from the foreign subsidiaries to the MNE headquarters, indicating that MNEs may be gaining more new knowledge from foreign subsidiaries than they are contributing to them. Ambos and Ambos (2009a) found in their analysis of foreign R&D activities in non-triad countries that all capability-augmenting units in their sample held a global market mandate characterized by a high degree of cross-border integration.

While most empirical studies on international R&D focus on factor quality-related aspects of economies of location, factor cost-related aspects have received only minimal attention. A notable exception is the study by Kumar (2001), who found that where there is an abundant local supply of scientists and engineers, the lower associated costs for labor are a significant motive for the localization of R&D activities both for U.S. MNEs and especially for Japanese ones. His findings showed that these kinds of R&D units focus not on adapting products or processes to local market re-

quirements but on providing cheap R&D services for the worldwide corporate network.

In summary, the previous discussion results in the following hypothesis:

Hypothesis 2: *Economies of location positively affect Global Innovation and Local Innovation at the cost of Implementation. The positive effect on Global Innovation is stronger than on Local Innovation.*

Cultural Distance

Culture comprises the values, beliefs, and assumptions of a group of people and shapes the interpretation of reality and messages (Hofstede 2001). Cultural distance can be defined as the extent to which the culture of the home country differs from that of the host country (Holtbrügge and Puck 2008). It describes factors that interfere with the flow of information to and from the host market (Johanson and Vahlne 1977) and that hamper knowledge-sharing within the MNE (Cho and Lee 2004). Cultural distance is generally thought of as an indicator of management and control costs across countries (Adler 2002; Erramilli and Rao 1993). The basic proposition is that culturally close host countries generally provide a more familiar operating environment and are more easily understood than distant ones. Cultural distance and the closely related concept of psychic distance (Dow and Karunaratna 2006) have been subject to numerous studies in IB research (see, e.g., Kirkman, Lowe, and Gibson 2006; Sivakumar and Nakata 2001). Prior research suggests that cultural distance between home and host country is likely to have a negative effect on FDI (e.g., Andersson and Forsgren 2000; Barkema, Bell, and Pennings 1996; Liu and Song 1997; Veugelers 1991), firm profitability (e.g., Gómez-Mejia and Palich 1997; Hutzschenreuter and Voll 2008), and subsidiary innovation (e.g., Nakata and Sivakumar 1996; Phene and Almeida 2008). Similarly, this studay expects that cultural distance has a negative influence on the localization of R&D activities in the host country.

The value of gaining access to specialized resources through localization of value

creation activities depends on the ability to combine these specialized resources with complimentary resources through the MNE's international network (Cantwell and Janne 1999; Malnight 1996). Cross-border integration of different types of knowledge and the resulting "cross-fertilization" (Asmussen, Pedersen, and Dhanaraj 2009, p.47) is considered to be a driver of innovation (Zander and Sölvell 2000). However, knowledge is not always codifiable in a way that allows an easy transmission and cross-border integration in the form of blueprints (Singh 2007). Tacit knowledge, as opposed to codified knowledge, is particularly difficult to codify and transfer (Brown, Dev, and Zhou 2003; Nelson and Winter 1982; Teece, Pisano, and Shuen 1997). If cultural frameworks of the host and home country do not have sufficient commonality, the transfer of knowledge and capabilities is less effective than in the case of a common cultural foundation (Griffith and Harvey 2001; Kedia and Bhagat 1988; Luo 2001b). From an MNE perspective, the ability to absorb, transfer, and exploit knowledge from a foreign subsidiary likely becomes increasingly difficult as the cultures of home and host country become more dissimilar. Hakanson and Nobel (2001) argue that "[t]he ease with which such [local] knowledge can be acquired and absorbed is related to the degree of cultural similarity/difference between the host country and the country of origin" (p.398). Essentially, a firm needs to overcome higher hurdles and faces higher coordination costs in transferring knowledge when the cultural distance is greater. This greater distance reduces the location advantage that FDI in R&D potentially provides and thus is assumed to negatively affect the localization of R&D activities abroad. Although modern communication technology could reduce or even eliminate some of the inherent challenges posed by distance, such as communication costs (Cairncross 1997), recent findings (e.g., Nachum and Zaheer 2005) remind us of what Ambos and Ambos (2009b) describe as the "persistence of distance in international business" (p.1).

The relationship between cultural distance and R&D internationalization, as described, can be grounded on different theories. The IPLC model implies that MNEs are subject to cultural barriers in host countries, preventing efficient communication and coordination among researchers, management, and lead customers in the home

country. These issues increase costs, reduce profitability, and threaten the success of R&D activities abroad. Major innovation activities are thus concentrated in close proximity to headquarters, and international transfer becomes more likely only at a later stage of product and technological maturity. The theme of increased communication and coordination costs in technology transfer resulting from different cultural backgrounds is also supported by scholars like Teece (1977), Lall (1979), and Caves (1996). The learning theory of internationalization assumes psychic distance as the key factor for internationalization (Johanson and Vahlne 1977; Nordström and Vahlne 1994). According to this strand, firms prefer to localize their value creation activities in countries with a similar cultural framework. Psychically close countries are more easily understood and offer a more favorable environment than distant ones (O'Grady and Lane 1996). Cultural proximity reduces the level of uncertainty and makes it easier to learn about and from the host country (Johanson and Vahlne 1993; Kogut and Singh 1988). Capability-based perspectives stress the importance of cross-border knowledge integration to build up technological advantages as a source of competitive advantage for the MNE (Almeida 1996; Almeida and Phene 2004; Frost 2001; Shan and Song 1997). A higher degree of interaction between the different parts of the MNE network leads to a better understanding of the transferred knowledge and thus increases the potential benefit for the MNE (Gupta and Govindarajan 1991; Subramaniam and Venkatraman 2001; Szulanski 1996). Transfers of knowledge to and reception of knowledge from another country are likely to be easier when the systems of underlying conventions of each country are similar (i.e., in cases of cultural proximity) (Macharzina, Oesterle, and Brodel 2001). A lack of context similarities, such as a cultural distance, requires a greater effort to transfer the knowledge in such a way that it conforms to existing expectations and ways of communicating (Tenkasi 2000). Likewise, evolutionary theory indicates that in the case of different cultural backgrounds, the cost of communication and knowledge transfer might be especially high (Kogut and Zander 1993, 1995). Accordingly, if technical resources are located in a country with a greater cultural distance, it might not be worthwhile to source them because the costs of combining this knowledge with that of the rest of the firm would be too high (see Asmussen, Pedersen, and Dhanaraj 2009). Hence, cultural distance

between the different units in the network is likely to aggravate the costs of knowledge transfer and learning about local conditions and make the value of the specialized resources in an individual host country environment accordingly less valuable to the MNE (Ambos, Ambos, and Schlegelmilch 2006).

In contrast to general IB literature, there has been only limited empirical research on the influence of cultural distance in R&D literature (see Ambos 2005). Hakanson (1992) found that cultural distance represents an important determinant for the location of foreign R&D activities for Swedish firms. Granstrand (1999) could confirm this finding for Swedish MNEs but not for Japanese firms. Also, drawing on a sample of Swedish MNEs, the findings of Hakanson and Nobel (2001) indicate that cultural distance between the home and host countries has a negative effect on reverse technology transfers from the foreign R&D unit to the MNE network, particularly in the case of greenfield investments. The study of Muralidharan and Phatak (1999) found that the farther the culture of the host country is, relative to the culture of the United States, the lower the R&D activity of U.S. MNEs in this country. Luo (2001b) argues that although MNEs may want to be more responsive to markets where there is a greater cultural distance, the presence of barriers arising from cultural distance is likely to have a greater effect on the actual level of local responsiveness in an emerging economy setting. Accordingly, Luo's findings indicate that subsidiary's local responsiveness is negatively associated with cultural distance between the host and home countries. Investigating barriers for managing R&D in China, Gassmann and Han (2004) identified the cultural gap as a major obstacle that Western firms have to overcome. Ambos and Schlegelmilch (2004) found support for the proposition that cultural distance between headquarters and the subsidiary represents a barrier to the use of international R&D projects.

The outlined reasoning leads to the following hypothesis:

Hypothesis 3: *The larger the cultural distance between the home country and the host country, the less attractive is the host country for the localization*

of R&D activities. Cultural distance negatively affects Local Innovation and Global Innovation in favor of Implementation.

Table 3 summarizes the hypotheses related to research question 2a on the relationship between location-specific features and R&D configuration. The direction of the expected relationship is indicated by '+' for a positive effect and '-' for a negative effect. Two symbols ('++') indicate a relatively stronger expected effect compared to the relationship marked with a single symbol ('+').

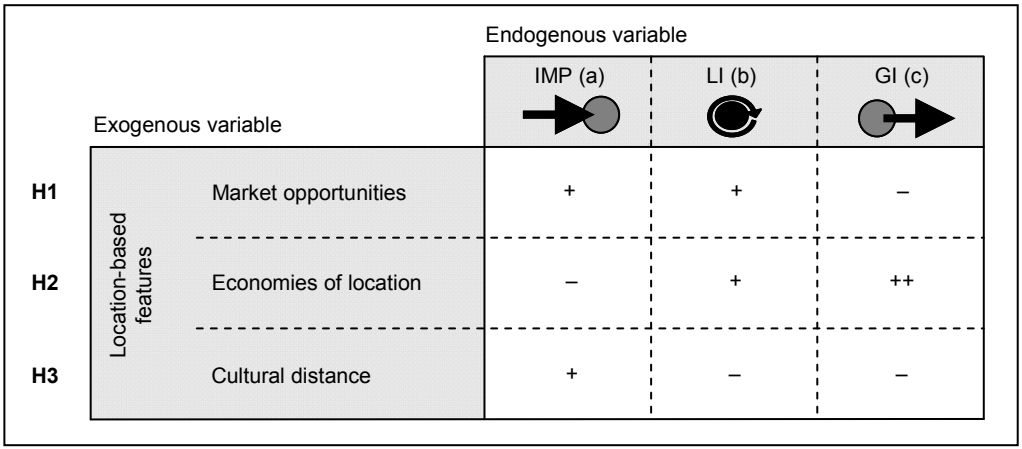


Table 3: Summary of Hypotheses for Research Question 2a

4.2.2 Industry-Based Features

Addressing research question 2b, the expected relationships between industry factors (dimension B of the research framework) and R&D configuration in emerging countries (dimension C of the research framework) are discussed in this section. In the following, hypotheses on the influence of technological complexity, technological turbulence, local responsiveness, and cost are developed.

Technological Complexity

Technological complexity describes the degree of novelty and inherent sophistication in product and process technology (Kim and Lee 2003; Steensma 1996). Evidence shows that complexity varies by industry, particularly in terms of product innovation (Porter 1985; Taggart 1998b). Although early literature argued that most sophisticated innovation activities would be highly concentrated in the home country (e.g., Hymer 1976), it has become evident that R&D activities and technological know-how can become geographically dispersed in the international network of an MNE (Cantwell 2009; Ernst 2002; Rugman and Verbeke 2009). However, because of their different characteristics, the R&D strategies under investigation are expected to differ regarding their ability to handle complex technologies

Technologically complex products require large investments in R&D, and technological improvements usually require substantial R&D spending, leading to escalating fixed-cost hurdles (Chung and Yeaple 2008). Pisano, Russo, and Teece (1988), for example, observe that initial development costs in high-tech industries increase with each new generation. Hence, instead of facing such cost hurdles in each host country, MNEs might concentrate their R&D efforts at one location and bundle the demand from different countries. An adequate location might either be in the home country close to headquarters or at other locations that have favorable factor endowments. Economies of scale can thus be realized if innovation activities are integrated across borders. With low technological complexity, the benefits from spreading fixed R&D costs across multiple countries are smaller, so that subsidiaries might have a tendency to perform their own R&D activities; this approach allows them to independently develop products according to local market requirements. In the case of Implementation, the subsidiary mainly relies on the R&D competencies of other members of the MNE network. In the case of Global Innovation, the subsidiary has certain output responsibility for a product or technology within the global company network. Such a subsidiary thus might operate according to a (world or regional) competence-creating mandate (Cantwell and Mudambi 2005) for a certain product or technology.

Contrary to the other two strategies, Local Innovation does not allow for economies of scale to be achieved. Because the subsidiary conducts its own distinctive R&D for the host country only, there is no integration and consequently no volume bundling across borders.

Furthermore, a higher degree of technological complexity is generally associated with greater subsidiary-level specialization in certain products or technologies (Cantwell and Vertova 2004). Specialized competencies are necessary because a subsidiary's ability to assimilate knowledge from its environment – its so-called "absorptive capacity" – depends on its existing knowledge in a particular field of technology (Cohen and Levinthal 1990). Consequently, specialization requires cross-border integration to allow other parts of the MNE network to benefit from distinct subsidiary competencies. Or as Cantwell (2009) puts it: "the most suitable and potentially innovative combinations of activity now commonly require international connections" (p.38). Again, because these "connections" occur for Global Innovation and Implementation, technological complexity is expected to favor these two strategies at the expense of Local Innovation.

There are different theoretical foundations for the relationships between technological complexity and R&D strategies. Neo-classical trade theories assume the most sophisticated activities to be highly concentrated in the relevant home base in the form of a fairly strict international hierarchy. Although this argument might explain the Implementation strategy, it does not explain Global Innovation. The technology gap theory goes a step further and provides indirect support for the expected relationship. This perspective argues that different technological development stages and comparative technological advantages act as determinants for trade. On the MNE level, this relationship implies that the cross-border exchange of value creation arises from the specialization of individual subsidiaries according to the local factor endowments. The diamond network perspective recognizes that the MNE generates its competitive advantage by using internationally dispersed competencies to access complementary host-country knowledge. To achieve this advantage, there are two prerequisites: lo-

calization and specialization (Asmussen, Pedersen, and Dhanaraj 2009). Localization of competencies is necessary to access geographically bound knowledge because proximity is conducive to knowledge sourcing and technological spillovers between firms (Brouthers and Brouthers 1997; Porter 1990, 1998). Specialization allows subsidiaries to absorb specific knowledge from their local environment. This line of reasoning is consistent with the capability-based perspectives. This view also recognizes the existence of specialized, high-level technological capability abroad and the need for firms to absorb foreign know-how. Localization of R&D activities and subsequent integration allow the MNE to pick up technical knowledge abroad and to transfer it to the home base or other parts of the global company network.

The question of technological complexity and its effect on configuration has also been addressed by a number of empirical and conceptual studies. Empirical literature on technology, and trade in general, offers broad support for a positive relationship between the two, including increasing cross-border integration: For example, Lall (1978) and Buckley and Pearce (1979) found a significant relation between R&D intensity and intra-firm exports from the headquarters to foreign subsidiaries. Siddharthan and Kumar (1990) showed that R&D intensity represents the strongest predictor of intra-firm, cross-border trade. In addition, the studies of Cho (1990), Benvignati (1990), and Kobrin (1991) revealed a positive relationship between technological complexity and cross-border integration within U.S. MNEs, and several additional studies established a link between product-related competitive advantage, which might be seen as the result of high-intensity R&D and cross-border integration (Beamish, Craig, and McLellan 1993; Cavusgil, Bilkey, and Tesar 1979; McGuinness and Little 1981).

Literature on international R&D contains relatively little empirical work on the relationship under investigation. Fors and Zejan (1996) found technological specialization of a particular host country in the industry to be a significant factor explaining the degree of localization of R&D activities for Swedish firms. Building on the seminal work of Mansfield, Teece, and Romeo (1980), Auerswald and Branscomb (2005) showed that the role of R&D in large corporations in the U.S. critically depends on the extent of

technical complexity of both current products and potential innovations. Kumar (2001) found that the scale of technological complexity has a positive effect on localization of R&D activities abroad by U.S. MNEs but not for Japanese firms. Investigating foreign-owned R&D activities in Europe, Cantwell and Piscitello (2000) report a close association between technological complexity and internationally integrated MNE networks. These observations result in the following hypothesis:

Hypothesis 4: *Technological complexity positively affects Implementation and Global Innovation at the cost of Local Innovation.*

Technological Turbulence

Industries are often described by their degree of instability. Following extant literature, technological turbulence is considered an exogenous factor describing the magnitude of change in the technological environment. It constitutes the dynamism and unpredictability of the future associated with product and process technologies in the industry in which a firm is embedded (Glazer and Weiss 1993; Jaworski and Kohli 1993). The stress of industry competitiveness calls for a shorter time to market and reduced innovation cycles. Thus, firms in industries with high levels of technological turbulence face a higher degree of change in technology than do firms that operate in industries with an established industry standard and low technological turbulence. Managing innovation in environments with uncertainty in technological opportunities represents a major challenge (Buganza, Dell'Era, and Verganti 2009). However, little research has focused on how technological turbulence, sometimes also referred to in the literature as industry clockspeed (Fine 1998), affects R&D configuration. To survive in a highly turbulent environment, a firm's R&D activities not only must deploy more flexible development processes but also must keep up with changing technological requirements through constant learning (Chiesa 1996a, 2001). Firms are thus likely to emphasize configuration strategies that allow for flexibility, that augment the range of available knowledge sources to monitor the latest technological developments, and that facilitate an effective application of this technology.

A direct access to foreign knowledge sources allows the firm to gain first-hand information on changes in the technical environment (Ghoshal and Westney 1991; Sheen 1992). It is therefore expected that new product development can be handled more easily by creative subsidiaries that possess own R&D competencies – what amounts to Local Innovatio. The management of independent R&D activities abroad is characterized by a considerably lower degree of complexity than that of internationally interdependent R&D (Gassmann and Zedtwitz 1999). The Local Innovation strategy enables the subsidiary to react quickly and with the greatest flexibility to changing technological and market conditions. However, because the scope of this strategy is limited to the respective host country, the subsidiary relies solely on its own technological capabilities. In contrast, the Global Innovation strategy is characterized by interdependencies with other parts of the firm network, which provide additional value from a group perspective, particularly in highly turbulent environments: Cross-border integration of geographically dispersed R&D activities enables the MNE to benefit from two "knowledge communities": from both the existing technological knowledge within the firm network and the knowledge that is embedded in different geographical locations (Frost 2001; Frost, Birkinshaw, and Ensign 2002). This duality offers advantages both on the input side and on the output side. Regarding innovation input, internationally interdependent affiliates enhance the scope of new technological sources in the group and allow the MNE to obtain a more varied flow of new product and process technologies (Hakanson and Nobel 2001), particularly if R&D work can be executed independently and simultaneously (Zedtwitz 2004). Accessing and integrating diverse knowledge bases from different international locations enhances the firm's drive toward and pace of innovative product development (Kotabe et al. 2007). Regarding the innovation output, an integrated network of foreign subsidiaries extends the firm's range of response to market signals (Papanastassiou and Pearce 1997), which allows for effective reactions to changing technological conditions.

Theoretical evidence for the relationship between technological turbulence and R&D configuration strategies is rather scarce. The diamond model recognizes that the local environment is an important source of innovation and crucial to the development of

capabilities and competitive advantage in an industry. Innovation represents a cumulative process that requires continuous refinement and improvement over time (Hargadon and Fanelli 2002). Based on this view, a highly competitive environment in the local industry might foster subsidiary innovation because it pushes the subsidiary to outdo rivals by being first on the market with new product or process technologies. Technological turbulence creates entrepreneurial opportunities for technological innovations that may challenge established norms and practices and represent a driver of industrial growth (Hall and Rosson 2006). Such pressure to innovate pushes the subsidiary to improve and grow to upgrade its competitive advantage (Davis and Meyer 2004). According to capability theories, firms in a highly dynamic environment facing a higher rate of change have to reconfigure their competencies to adapt to rapid change. According to this view, innovativeness describes the ability of a firm to seek new ideas, to accept innovation, and to support idea generation (Hanvanich, Sivakumar, and Hult 2006). These tasks might be best performed or supported by local R&D activities that enable the subsidiary to adjust quickly to rapid technological changes and to leverage the business opportunities that such changes offer. Furthermore, in cases where technological turbulence is high, idea homogeneity impairs creativity (Moorman and Miner 1997). Therefore, from an MNE perspective, localizing and integrating R&D activities in different countries abroad enables the firm to access different sources of technological capabilities, ensuring that it continuously generates new ideas and inventions regarding product and process technologies.

In addition, there exist various conceptual and empirical works that allow for the prediction of a causal relationship between technological turbulence and the configuration of R&D activities. A review of relevant literature revealed four major lines of reasoning.

First, a recent stream of studies in the management literature has argued that when facing turbulent environments, firms should deploy more flexible development processes (Buganza, Dell'Era, and Verganti 2009). Moreover, it stresses the essential role of improvisation to cope with the environmental changes (Akgün et al. 2007). Simi-

larly, research on environmental turbulence has suggested that firms adopt a less centralized, more organic structure in dynamic, uncertain conditions (Calantone, Garcia, and Dröge 2003). Iansiti (1995) found that the need to react to frequent and substantial change requires a flexible innovation approach that embraces change. Investigating foreign R&D activities in China, Zedtwitz (2004) asserts that the dynamics in some industries push foreign R&D units to speed up time-critical feedback and prototyping cycles in the product development process. This acceleration requires that critical decisions are made rapidly and independently at the subsidiary level, avoiding excessive coordination with other parts of the MNE network. Ketokivi and Ali-Yrkkö (2009) found empirical evidence that an increasing rate of technological change makes co-location between R&D and manufacturing more likely because both functions are more dependent on one another compared to stable industries and because such rates of change place a heavier burden on managing interdependencies. Accordingly, foreign subsidiaries that face high turbulence are expected to emphasize speed-to-market activities and maintain rather independent local R&D activities that allow the subsidiaries to be flexible and thus to tolerate a higher degree of risk of technological change.

Second, literature on international R&D has shown that a high degree of market proximity offers firms the opportunity to try out new products with sophisticated local lead customers (Florida and Kenney 1994; Gupta, Govindarajan, and Wang 2008). R&D activities are found to be located first in dynamic markets to access impulses for the innovation process through local presence and interaction with customers (Gerybadze and Reger 1999). Such an interaction allows the subsidiary to receive customers' input and feedback regarding their needs and potential problems at an early stage of the innovation process. Customer involvement enables the firm to make changes in the product specifications or designs earlier in the process, reducing both incremental cost and time (Thomke 1997). Close interaction with local customers speeds up the innovation process, allows for reduction in the time to market, and improves the success of new products (Brockhoff 2003). These benefits are expected to be of particular importance in environments of high technological uncertainty and con-

fusion, where being at the technological forefront and meeting customer needs are essential to firm success.

Third, literature on technology sourcing argues that rapid technological changes require the MNE not only to develop new technologies in a shorter time but also to constantly monitor new technological developments in different locations. Knowledge represents a productive source for innovation (Nonaka and Takeuchi 1995). To successfully innovate and develop new products, firms need to look for external signals, recognize the value of the information, absorb it, and apply it (Cohen and Levinthal 1990). These needs hold a fortiori for environments with a high pace of technological change. Already Hakanson and Nobel (1993a; 1993b) and Dunning (1994) noted that foreign R&D activities might be caused by the motive to acquire or gain insights into technological knowledge abroad. This “monitoring technological development abroad” or “listening post” function recognized the need for firms to absorb foreign technological knowledge that could be picked up by the subsidiary and transferred back to the home base. By now, technological listening posts have received quite a lot of conceptual and empirical research attention, particularly in the context of knowledge sourcing; however, a comprehensive description of listening posts is still missing. Extant literature establishes that listening posts allow firms to monitor the latest technological developments and to exploit tacit and locally embedded technological knowledge from different locations while reducing the need for larger financial investments that are necessary for a full-fledged R&D laboratory abroad (Hegde and Hicks 2008; Le Bas and Sierra 2002; Patel and Vega 1999; Zedtwitz and Gassmann 2002). The introduction of listening posts in practice goes back to the early 1980s, when Japanese MNEs established R&D units in leading centers of excellence abroad, first in the United States and Great Britain, then later in other countries. These units had the task of sourcing technological knowledge abroad and to support the firms in their strategy as imitators and fast-followers. Gassmann and Gaso (2004) distinguish between three different types of knowledge that is processed at listening posts: technologies, applications, and trends. Technological knowledge mainly consists of sophisticated and complex tacit knowledge on a certain technology. Such knowledge might be

spread at different locations or concentrated in one specific region or cluster. Application knowledge contains information about future products and applications that are based on existing technologies (e.g., by migration or recombination). Knowledge on trends comprises both macro- and micro-trends. The former are fundamental market shaping developments that in the long run potentially have significant effects on business models and market characteristics. The latter are more specific, short-term trends reflecting what is ”hot” and ”in”. In all three contexts, listening posts exhibit local embeddedness, as well as a high degree of interdependency with other R&D units in the MNE network.

Finally, frequent technological changes imply shorter product lifecycles and the need for firms to invest frequently in new fixed assets. Thus, firms in such volatile environments more often face an opportunity to locate value creation activities abroad. Accordingly, technological turbulence might act as an incentive to offshore more established products to free up domestic capacities for the latest technologies (DuBois, Toyne, and Oliff 1993). Because of advantageous factor costs, emerging countries represent an attractive location for the manufacturing of price-sensitive products. R&D activities might be collocated to support manufacturing operations (e.g., with process, material, or product improvements). As such, new product introductions can act as an incentive to localize R&D activities abroad.

This discussion leads to the following hypothesis:

Hypothesis 5: *Technological turbulence positively affects Global Innovation and Local Innovation at the cost of Implementation. The positive effect on Global Innovation is stronger than on Local Innovation.*

Local Responsiveness

Local responsiveness is defined here as the need for the development products to meet specific local market conditions. The need for location-specific developments or adjustments might be caused by differences in consumer tastes and preferences, by

diverging local business practices, or by host government requirements (Erickson 1990; Prahalad and Doz 1987), depending on the structure and characteristics of the industry in which the subsidiary participates (Birkinshaw, Morrison, and Hulland 1995; Chang and Singh 2000; DuBois, Toyne, and Oliff 1993). The stronger the effect of these forces, the higher the need for the MNE to customize its products to local requirements. The perceptions of the subsidiary managers abroad about the need for local responsiveness might differ from those of the parental managers in a head office (Luo 2001b). In contrast to standardized "world products", customized products require user-need-related knowledge, which is located in the host market. A foreign subsidiary is in a superior position to screen and appraise local dynamics and impediments (Birkinshaw 1996). The subsidiary can internalize the user need through its proximity to and participation in the local market (Anderson and Gatignon 1986; Kotabe et al. 2007). The need for local responsiveness reduces the potential benefits that might be gained from standardization, centralization of value creation activities, and volume bundling across borders (Bartlett and Ghoshal 1989). Thus, the need to react to specific local requirements is expected to have important implications for the configuration of R&D activities.

Both the Implementation strategy and the Global Innovation strategy are characterized by centralization of certain R&D activities in one country, integration across borders, and the aim to realize economies of scale. For Implementation, there are no or only very limited local R&D activities in the host country, which allows for only minor (if any) product adaptations on the subsidiary level. Furthermore, Implementation lacks proximity to local customers, which impedes the early involvement of market and customer application know-how that is necessary for the development of location-specific products (Gassmann and Zedtwitz 1998). Hence, a negative relationship between Implementation and local responsiveness is expected.

When the firm can be closer to its customers (Casson, Pearce, and Singh 1992), localization of R&D activities enables the subsidiary to improve responsiveness to local needs in terms of both time and relevance (Chiesa 1996b; Dunning 1993; Gammeltoft

2006). Global Innovation does show a high degree of local R&D competencies, but the subsidiary's host country market is not the focus of this R&D strategy. Instead, the subsidiary renders its innovation activities for other units of the MNE network and thus for third markets. Again, because of the bundling of demand across different countries, this strategy is expected to be negatively affected by divergent local requirements in different host countries.

Only Local Innovation is expected to be positively related to local responsiveness. The strategy benefits from the proximity to the local customer and its focus on the host market. Moreover, this configuration implies fewer linkages with other parts of the MNE network, allowing the R&D unit to make decisions with sensitivity to the local context without much consideration of the activities or requirements of other subsidiaries (Taggart 1997).

Theoretical evidence for a causal relationship between local responsiveness and international R&D strategy can be found in different strands of theory. The trade barrier approach postulates that localization of value creation activities in a host country represents a means to circumvent trade barriers. Trade barriers might occur because of government interventions and administrative practices, such as regulations, standards, or norms. Governments in emerging countries in particular tend to protect certain important or infant industries and require foreign firms in these industries to develop, produce, or procure local materials and parts (see Luo 2001b, p.458). Non-tariff barriers, such as local content requirements, oblige the MNE to adapt its products accordingly and thus motivate the localization of R&D activities in the host country. Differences in customer requirements and tastes also might be interpreted as customer-induced trade barriers because they lead to a need to develop customized products for the host country and thus are expected to be positively related to the Local Innovation strategy. According to the logic of the IPLC theory, the need for adapting products to local market requirements represents the primary motive for the localization of R&D activities abroad. Foreign R&D units are supposed to support subsidiaries in adapting existing products and processes to the specific host country condi-

tions. The amount of adaptation that can be performed in the host country is rather limited because the assumption is that foreign R&D units possess only minor

Various conceptual and empirical evidence for the expected relationships is available. The tensions between local responsiveness and global integration have been described and analyzed by a considerable body of IB literature referring to the integration-responsiveness framework. This perspective considers international strategy as managing the tension between global integration and local responsiveness. Its roots go back to the work of Doz (1980; 1986), Bartlett (1986), and Prahalad and Doz (1987), and it has been empirically tested by various authors (e.g., Ghoshal and Nohria 1993; Harzing 2000; Johnson 1995; Leong and Tan 1993; Roth and Morrison 1990). Global integration concerns the coordination of activities across countries in an attempt to build global networks and to take maximum advantage of similarities across locations to realize synergies and thus reduce costs. Responsiveness, in this perspective, refers to subsidiary autonomy that allows the subsidiary to respond to local competitive or customer demands and tries to respond to specific needs in the host countries (see Luo 2001b, p.452). Bartlett and Ghoshal (1989) argue that each business function is subject to different degrees of cost pressure, on the one hand, and pressure for local responsiveness, on the other hand, both of which influence the configuration of the value creation. Alternative labels for responsiveness applied in the literature are “political imperatives“, “local differentiation“, “national responsiveness“, ”need for local adaptation“, “globalization barriers“, and “forces for local responsiveness“. Bartlett and Ghoshal (1990) conclude that the “[c]urrent fascination with globalization of markets tends to overlook the fact that while the forces of globalization have certainly strengthened in many industries, need for responsiveness to national demands and local differences has not disappeared, and often has increased“. In this context, Bartlett and Ghoshal assert that “local-for-local innovations are essential for responsiveness to the unique attributes of each of the different national environments in which the MNC operates” (p.220).

Empirically, the need for market proximity to ensure local responsiveness was first

investigated in the context of manufacturing. However, Schoenberger (1985) found that the need for market information continues to be critical for the configuration of value creation activities even after the product has been launched, at later stages of the product lifecycle. Based on this finding, DuBois, Toyne, and Oliff (1993) developed a conceptual framework that identifies industry characteristics influencing a firm's configuration; they reported a positive relationship between the need to respond to local customer needs and the need for the localization of value creation activities. In line with Hallen and Johanson (1985), the authors found that the need to localize value creation activities directed toward adaptation to specific market requirements holds particularly in industrial markets. This need remains because the product offered consists of a "total package of benefits", including not only the physical product but also such intangibles as technical assistance, assurance of supply, or maintenance (see Schoenberger 1985, p.496). Local R&D competencies might help a firm to offer customized products and a comprehensive portfolio of related services to customers in the host country. Moreover, a local R&D expertise might be necessary to support other functions and activities in the host country, such as technical sales, production, or after sales services.

In literature on R&D internationalization, empirical support is in the first instance provided by the diverse types of foreign R&D strategies and roles that, by definition, aim to develop products for specific local customer needs, such as inter alia the indigenous technology unit by Ronstadt (1978) and the locally integrated laboratory by Pearce and Papanastassiou (1999), Papanastassiou and Pearce (2005), and Manolopoulos, Papanastassiou, and Pearce (2007). Further empirical evidence comes from Birkinshaw, Morrison, and Hulland (1995), who report a significant link between structural forces, such as market demand standardization and economies of scale, and the centralization of development activities. This link indicates, in reverse, an expected negative effect of local responsiveness on Implementation and Global Innovation because both strategies are characterized by concentration of value creation in one location and cross-border integration. The analysis of foreign R&D activities in China by Luo (2006) finds that the adaptation of products to specific local re-

quirements requires that autonomy be assigned to the foreign R&D unit, thus providing adequate decision-making power to respond to local needs and to develop market-specific products or technologies. This finding is consistent with earlier ones pointing out that localization stimulates business success when product differentiation and customer responsiveness are required to gain a local competitive advantage (Porter 1990) and that it helps maximize subsidiary initiative and the proactive pursuit of new business opportunities (Birkinshaw 1996). Similarly, Harzing (2000) finds that having production and R&D close to the end customer makes it easier to perform the adaptations that are required to sell the product successfully. Hegde and Hicks (2008) assert that, for foreign subsidiaries of U.S. MNEs, the location of R&D activities in a country is driven by the need to modify products for a market. Finally, the study of Manolopoulos, Papanastassiou, and Pearce (2007, p.678) reveals that the most influential motivation for R&D activities in peripheral economies is for the adaptation of product and/or process technologies, along with having R&D serve as a local support function.

In sum, this examination leads to the following hypothesis:

Hypothesis 6: *Local responsiveness positively affects Local Innovation. Negative effects are expected for Implementation and Global Innovation.*

Cost Pressure

MNEs facing strong cost pressure in global markets try to minimize unit costs; they seek to locate value creation activities in the locations offering the most favorable cost conditions. Increasing cost pressures also might motivate firms to rationalize their innovation activities, locating part of their R&D in emerging countries to gain access to abundant trained engineers and R&D personnel at lower cost, compared to those in developed countries. Thus, it is expected that pressures for cost competitiveness favor localization of R&D activities in emerging countries. Local Innovation and Global Innovation are both characterized by a high degree of local value creation, allowing firms to benefit from favorable labor costs in the host country. While the former strat-

egy is geared toward supporting the local subsidiary in the host country to increase competitiveness, the latter provides R&D activities for other units of the MNE network. Global Innovation allows the firm to internalize international differences in labor costs (Kumar 1994), exploit economies of scale, and reduce the amount of duplicate R&D to reduce the firm's overall innovation costs (Gassmann and Zedtwitz 1999). In the case of high cost sensitivity, MNEs tend to locate their manufacturing activities in low-cost countries (Moore 1993; Nassimbeni and Sartor 2005; Summary and Summary 1995). The foreign subsidiary might then have a local R&D unit to support the factory with technological product and/or process improvements and upgrades (Odagiri and Yasuda 1996). Co-locating R&D and manufacturing activities reduces costs of international coordination, allowing the firm to achieve further cost efficiencies. Implementation is not expected to a favorable strategy in case of high cost pressure. Although the strategy allows the realization of economies of scale because of cross-border bundling of activities, the predominant part of R&D is usually performed close to headquarters (i.e., in a high-cost environment with severe labor cost disadvantages).

Theoretical evidence for a relationship between cost pressures and R&D strategies comes from IPLC theory. It assumes that cost pressure intensifies with maturity; in later life cycle stages, standardization of technologies makes price a more significant competitive factor. The theory postulates that increasing concerns for cost competitiveness force MNEs to relocate value creation activities to locations offering lower labor costs. In later life cycle stages, there is a shift in the nature of competitive requirements away from innovative capabilities and toward factors such as cost and process innovation (Nadeau and Casselman 2008). This move suggests a positive relationship between cost pressures and localization in emerging countries. The cost advantage theory and the factor proportion theorem assume that specialization and cross-border integration occur as a result of differences in factor costs, indicating that R&D competencies for specific products or technologies might be bundled in one specialized unit that provides service to other parts of the company network. High cost pressure might motivate MNEs to locate these specialized units in emerging countries to benefit from labor cost advantages.

Conceptual and particularly empirical evidence on the relationship between cost pressure and R&D configuration in emerging economies is relatively scarce. In contrast to market- and capability-related factors, cost-related aspects have received only little attention in international R&D literature. Some studies argue that labor cost advantages act as an efficiency-seeking motive for the localization of R&D abroad (Dunning and Lundan 2009; Gassmann and Zedtwitz 1998). The work of Sachwald (2008) reports an "increasing pressure on the cost of R&D" (p.369) and notes that cost efficiency has become an increasingly important motive for the internationalization of R&D activities, particularly in emerging economies. Similarly, Edler (2008) argues that a recent shift of focus has made factor costs increasingly relevant for localization decisions of R&D activities. He attributes the rising cost pressure on R&D to three trends: the increasing availability of low-cost expertise in emerging countries, the enhancement of enabling technologies, and the availability of advanced organization capabilities to cope with a global division of labor. In an empirical study of R&D internationalization in U.S. and Japanese MNEs, Kumar (2001) found that the relative costs of qualified engineers positively affects the localization of R&D, particularly for Japanese firms. Based on a survey and in-depth interviews, Liu and Liu (2004) investigated R&D internationalization of IT companies with Taiwan as the home country and China as the host country. The authors assert that the competitive environment in the industry and the increasing need for cost reductions has induced Taiwanese companies to set up manufacturing facilities in China to benefit from cost advantages there. Hence, they conclude that "[t]he success of gaining advantages in manufacturing efficiency evolves quite naturally into gaining advantages in R&D cost. Young engineers in mainland China receive lower wages compared to those in Taiwan, and this cost advantage increases the motivation of Taiwanese companies to establish R&D units in mainland China" (p.458). Regarding cross-border integration, Gassman and Zedtwitz (1999) identify a trend toward interdependent R&D units, arguing that "[p]ressure of cost reduction forces companies […] to focus on a small number of leading research centers (re-centralization). The goal of this consolidation is to better exploit scale effects and to improve the coordination of worldwide dispersed R&D activities, simultaneously reducing the amount of duplicate R&D and intensifying cross-

border technology transfer" (p.246). Because of favorable factor cost conditions compared to developed countries, R&D units in emerging economies might benefit from this trend, particularly given greater cost pressures. Based on quantitative and semi-quantitative research, Zedtwitz (2004) finds that the search for increasing cost efficiency motivates MNEs in some industries to move "world product mandates" to R&D units in China. These units have responsibility for some of the firm's products and technologies, indicating interdependencies with other units and a close integration in the overall firm network.

In sum, the outlined reasoning leads to the following hypothesis:

Hypothesis 7: *Cost pressure positively affects Local Innovation and Global Innovation at the cost of Implementation.*

Summarizing the hypotheses related to research question 2b on the relationship between industry-specific features and R&D configuration, Table 4 summarizes the expected direction of effects. Again, two symbols ('++') indicate a relatively stronger expected positive effect compared to the relationship marked with a single symbol ('+').

		Exogenous variable	Endogenous variable: IMP (a)	Endogenous variable: LI (b)	Endogenous variable: GI (c)
H4	Industry-based features	Technological complexity	+	–	+
H5	Industry-based features	Technological turbulence	–	+	++
H6	Industry-based features	Local responsiveness	–	+	–
H7	Industry-based features	Cost pressure	–	+	+

Table 4: Summary of Hypotheses for Research Question 2b

5 Methodology and Research Design

Methodology is a system of methods and rules to facilitate the collection and analysis of data (Hart 1998). This chapter describes the applied methodological approach to empirically test the developed research framework. The first section provides some basic considerations on the method of data collection, explains the data gathering procedure, and includes an overview of the characteristics of the obtained data sample. The second section provides an overview of the approach to data analysis, the applied statistical methods, and the validation procedures.

5.1 Data Collection and Sample

This thesis uses a large-scale empirical research approach. A quantitative analysis may be based on either archival or survey data. This section first outlines the reasons for applying a large-scale quantitative analysis based on primary survey data. Thereafter, it describes the research object, the design and testing of the questionnaire, and the execution of the data collection before it outlines the characteristics of the of the data sample.

5.1.1 Methodological Approach

Depending on the objective of the study, the choice has to be made between qualitative and quantitative research methods. The primary objective of this thesis is to obtain generalizable results and to confirm a priori specified hypotheses, which will be derived from extant theories and empirical literature. For this purpose, a quantitative analysis, typically involving a large number of observations, should be applied (Polonsky and Waller 2010). Thus, the configuration of foreign R&D and its influencing factors is studied by collecting primary data based on a standardized questionnaire. The data were subsequently analyzed using SEM.

The choice between objective archival data and subjective survey data largely de-

pends on data availability. Advantages of archival data are objectivity and instant accessibility. However, such archival data pose several challenges and limitations. Available data often only cover the macroeconomic level, which does not allow analysis on the individual firm or subsidiary level. Publicly available export data on products do not reflect the real cross-border transfer of R&D results. Moreover, data quality might be an issue, particularly in the context of emerging economies. Both data accuracy and inconsistencies with regard to definitions and calculations within and across countries represent major data collection problems in emerging economies (Hoskisson et al. 2000, pp.257 et seq.).

Particularly in the research fields of international R&D, valuable contributions have been made by analyzing patent data and patent citations. Patents are thereby used as indicators of technological output and innovative capabilities (Hall, Jaffe, and Trajtenberg 2000) and to capture cross-border knowledge flows (Almeida 1996; Almeida, Song, and Grant 2002; Song, Paul, and Wu 2003; Song and Shin 2008; Ziedonis 2004). Despite its merits (see, e.g., Belderbos 2001; Cantwell and Janne 1999; Le Bas and Sierra 2002), patent data analysis suffers from some inherent constraints. For example, firms cannot or do not patent all their innovations. Patenting propensity and patent strategies generally vary across industries, countries, and firms (Ambos 2005; Ernst 1995). Thus, measuring R&D configuration on the basis of patent output neglects all foreign R&D activities that do not involve patent output. Particularly in the context of emerging economies, this neglect might represent a significant issue because the nature of R&D activities and the institutional environment in these countries likely do not favor patent activities. Moreover, patent analysis often relies solely on the number of patents granted to measure R&D output, without considering that there might be acute differences in patent quality and thus in the value of the output (Ernst 2001, 2003a).

Considering foreign R&D activities of MNEs, Ambos (2005) concludes that “the degree to which secondary data sources are able to map firm level data is ultimately limited” (p.396) – which might particularly apply in an emerging economy context.

Moreover, survey data are considered “the most reliable way to capture […] constructs, owing to the tacit and industry- and firm-specific nature of location advantages” (Asmussen, Pedersen, and Dhanaraj 2009, p.48). Using survey data also allows for the inclusion of small and medium-sized enterprises (SME), family-owned enterprises, and other companies not publicly listed. These firms generally are restrictive with regard to publishing company data. Thus, the use of survey data helps to circumvent problems associated with secondary data and represents the more suitable approach for this study.

5.1.2 Research Object

The definition of the research object has two parts: the definition of the unit of analysis and the choice of the survey sample. The unit of analysis represents the type of entity under investigation. The choice of the survey sample desribes the scope of the empirical investigation and includes the decision about relevant industries, as well as about the home and host countries.

During the past few decades, the management of foreign subsidiaries has emerged as a distinctive field of investigation for IB researchers (see Manolopoulos 2008). This “subsidiary view of the MNE” (Davis and Meyer 2004, p.360) accommodates that the role of individual foreign subsidiaries is much more complex than expected in earlier literature because each subsidiary can be simultaneously a recipient and a contributor of knowledge, products, and services (Asmussen, Pedersen, and Dhanaraj 2009). Having placed subsidiaries at the center of the examination, recent literature considers a subsidiary to be an organization with the potential for autonomous decision-making and strategy formulation (Ambos, Andersson, and Birkinshaw 2010; Birkinshaw, Toulan, and Arnold 2001; David 2005; Venaik, Midgley, and Devinney 2005). White and Poynter (1984) were among the first to analyze MNE strategies from a subsidiary perspective. Since the seminal work by Bartlett and Ghoshal (1989) on forces for global integration and local responsiveness, a growing body of IB research

has been building on the idea of the MNE as a network of specialized, interdependent units (Phene and Almeida 2008). Thus, the exploration of subsidiary roles, charters, and mandates has become a central issue in the discussion of the strategy and structure of MNEs (Cantwell 2009; Nachum and Zaheer 2005; Porter 2000; Taggart 1998c). For a recent review of the literature on subsidiary roles, see Manolopoulos (2008).

The literature shows that roles of subsidiaries vary substantially even within the same MNE (Gupta and Govindarajan 1991; Jarillo and Martinez 1991). Moreover, individual subsidiary-level factors are an important determinant of the scope of foreign activities (Gupta and Govindarajan 2000; Mu, Gnyawali, and Hatfield 2007). However, Cantwell and Mudambi (2005) argue that most of the discussions in the field of international R&D focus on the MNE at a group level rather than examining strategies at the subsidiary level (see also the literature review in Chapter 2). In the same way, Davis and Meyer (2004) assert a lack of subsidiary level surveys, although "the actual investment in developing resources and capabilities is subject to initiatives made at the subsidiary level" (p.362). To enable the study of intersubsidiary variations in R&D configuration, this research thus follows the spirit of this "more recent strand of literature" (Cantwell and Mudambi 2005, p.1111) and takes the individual foreign subsidiary as the unit of analysis. This applied "subsidiary view" allows a more detailed investigation than would an aggregation at the MNE, industry, or regional level.

Because of the complex nature of the phenomenon under investigation and the relative dearth of previous empirical work on it, this study follows the argumentation of Gupta and Govindarajan (2000, p.474) and considers the level of the *individual* subsidiary; interrelationships between subsidiaries on the MNE level exceed the focus of this research project. This conscious limitation of the focus corresponds to current research practices (see, e.g., Asmussen, Pedersen, and Dhanaraj 2009, p.48). Moreover, the analysis in this study focuses on international configurations within firm boundaries (i.e., foreign R&D in majority-owned and wholly owned foreign affiliates). Internal R&D requires a longer term commitment to a localized research effort by the

firm than does a research agreement. This research project follows Kuemmerle (1999a), who concludes that "(…) to understand the full dimension of the international dispersion of firm R&D, it seemed necessary to study FDI" (p.5). Because contractual R&D or research agreements are not considered, ownership of at least 51% is set as a precondition of the analysis. This restriction of the sample is also consistent with other recent studies on internationalization of R&D (e.g., Feinberg and Gupta 2004, p.830; Hegde and Hicks 2008, p.395). Moreover, the focus on internal R&D considers that, despite a slightly increasing share during the past decade, external R&D still plays only a minor role. In German companies, the share of in-house R&D accounts for about 80% of total R&D expenditure (Stifterverband 2010, p.11).

Global R&D expenditure has grown rapidly over the past decade. Yet the world's largest R&D spenders are concentrated in a few manufacturing industries: electronics, automotive, and pharmaceuticals. These industries are also the most internationalized in terms of R&D. Companies in the chemical and pharmaceutical industries locate almost 50% and 40% of their R&D, respectively, outside their home countries (UNCTAD 2005). Hence, this research project focuses on the following research-intensive manufacturing industries: automotive (SIC-code 37), mechanical engineering (SIC-codes 34 and 35), electrical engineering (SIC-codes 36 and 38), chemical, and pharmaceutical (both SIC-code 28). This choice corresponds to Audretsch and Weigand (2005), who classify these industries as knowledge-intensive (hi-K) industries. These industries show the highest R&D ratios, as well as the highest share of firms with an R&D budget and in-house R&D laboratories. Moreover, Audretsch and Weigand argue that "economic activities in these industries are specifically based on knowledge generated in natural sciences" (p.599).

Prior research reports different patterns in international R&D, depending on a company's home country (Edler, Meyer-Krahmer, and Reger 2002; Granstrand 1999; Hakanson and Nobel 1993a, 1993b; Kumar 2001; Van Ark et al. 2008). Gerybadze and Reger (1999) find that home market characteristics, such as size and concentration of critical assets, influence the internationalization strategy and global manage-

ment processes. Moreover, with the limitation to MNEs from a single home country, influences from cultural differences between headquarter locations can be avoided (Ambos 2005). Germany has been chosen as the country where the headquarters of the surveyed subsidiaries are located. German companies rank third in business R&D spending (UNCTAD 2005). In 2007, R&D expenditures of German foreign affiliates accounted for nearly EUR 9.5 billion, of which almost 9 billion was allotted to the manufacturing industries (Stifterverband 2010). The five selected industries constitute more than 80% of all German FDI in manufacturing and represent the majority of German exports. Also, in terms of turnover and number of employees abroad, these industries cover the majority of foreign activities of German manufacturing MNEs (see Federal Statistical Office Germany 2009; German Central Bank 2008).

Most of the existing research on the internationalization of R&D has focused solely on R&D in triad countries: the United States, Japan, and Western Europe. Brouthers, Brouthers, and Werner (2001) and Manolopoulos, Papanastassiou, and Pearce (2007) investigate multinationals' R&D in more peripheral European economies, including Central and Eastern Europe and Greece. Very little research has been done with regard to R&D in emerging countries. Exceptions are Gassmann and Han (2004) and Zedtwitz (2004), who examine foreign R&D units in China. However, emerging countries have recently gained importance as locations of R&D. In the past ten years, the rise of foreign R&D activities was particularly strong in emerging countries (UNCTAD 2005). Therefore, R&D activities in emerging countries are the main focus of this research project. To force heterogeneity into the sample, the host countries selected for this study include Brazil, Russia, India and China (BRIC) which account for about 40% of the world population as well as ASEAN countries. These countries were selected for this study because they are the four large emerging countries whose economies are expected to become the largest global economic group by the middle of this century (Cheng et al. 2007). Actually, China is already regarded as the most attractive prospective R&D location, and India ranks third, behind the United States (see UNCTAD 2005, pp.125 and 153). In addition to the BRIC heavyweights, the South East Asian countries are included in the sample because they belong to the

most important emerging economies (World Economic Forum 2009).

5.1.3 Key Informant

A key informant has to be able to evaluate the inbound and outbound intra-firm transfers of R&D results and to assess derivers and environmental factors of the subsidiary. Choosing subsidiary respondents rather than headquarter respondents holds the advantage that subsidiary level respondents are directly engaged in the local environment and therefore are "more acquainted with its characteristics" (Asmussen, Pedersen, and Dhanaraj 2009, p.48). With regard to the evaluation of location-specific advantages and environmental factors, Davis and Meyer (2004) argue that "the subsidiary manager, embedded in the local environment […] may well have a clearer understanding of the strength and value of these advantages in practice" (p.362). In principle, it would be desirable to include multiple informants from each subsidiary. However, this approach was not feasible because of a considerable increase in the survey effort and complexity. Moreover, surveying multiple informants within one organizational unit poses issues of data aggregation across multiple informants (Kumar, Stern, and Anderson 1993). Therefore, one key informant per subsidiary was chosen. Scholars criticize that this approach potentially leads to overstating or understating of phenomena, depending on the key informant's personal characteristics (e.g., experience or individual knowledge), which might lead to a reduced validity of the collected data (Bagozzi, Yi, and Phillips 1991; Ernst and Teichert 1998). To counter these problems, the heads of foreign affiliates were chosen as a respondent group, assuming that these informants are most knowledgeable about the international configuration of their subsidiary. Their knowledge leads to both greater reliability and higher validity. Moreover, Ernst (2003b) found that, in particular, functional and hierarchical affiliation might contribute to informant bias. He concludes that the ideal key informant is knowledgeable but not directly involved. Under these conditions, heads of foreign affiliates are expected to be the best choice. They are not functionally biased because they are responsible for all business functions of their affiliate.

This choice also follows the suggestion formulated by Leong and Tan (1993), who argue that “respondents should be executives of sufficiently high […] standing to possess the likely expertise and bird’s eye view required to furnish an informed perspective of their organization’s international management structure” (pp. 453-454).

5.1.4 Questionnaire Design and Pretest

The questionnaire is based on the operationalization of constructs as described in Chapter 6. To ensure the reliability of responses, most variables use closed questions that are formulated as answers (see Bourque and Fielder 1995) and are measured on a five-point Likert scale, ranging from ”strongly agree” to “strongly disagree” or from “not important at all” to “extremely important“. Likert scales are widely used in survey research and are the most common approach in applied social sciences (Schnell, Hill, and Esser 2005). Following the recommendation of DeVellis (2003), only positive wordings were included for closed questions to enhance user friendliness. With regard to the endogenous constructs, it was necessary to obtain percentage information. Furthermore, absolute values were queried for some of the contextual variables, such as subsidiary age or number of employees.

The development of the questionnaire followed the guidelines of Bourque and Fielder (1995, p.55), who recommend starting with easy and general questions and putting more complex questions in the middle of the questionnaire. The first page of the questionnaire provided an introduction for the respondent explaining the goal of the survey and the incentives to participate, assuring confidentiality, and including hints for completion. The subsequent pages contained questions related to internationalization motives, configuration of the value creation, company characteristics, product characteristics, and finally personal characteristics of the respondent.

The questionnaire was carefully designed considering the potential bias arising from the measurement method when both the dependent and independent variables are perceptual measures derived from the same respondent (Podsakoff et al. 2003; Pod-

sakoff and Organ 1986). Addressing potential problems in the comprehension stage of the response process, the formulation of the questions was systematically examined to ensure a precice and consistent wording and to avoid ambiguous, vague and unfamiliar terms in the questionnaire (see Chang, Witteloostuijn, and Eden 2010; Harrison, McLaughlin, and Coalter 1996; Lindell and Whitney 2001).

To ensure consistency across the seven different countries in which the survey was conducted, the questionnaire was developed in only two language versions: German and English. This approach was considered appropriate because German and English are generally used as business languages in foreign subsidiaries of German MNEs. A translation-back translation procedure (see Brislin 1980) was applied to minimize variance attributable to language differences and to ensure cultural equivalency (Hoskisson et al. 2000; Riordan and Vandenberg 1994).

Pre-tests, or pilot tests, are considered as an integral part of questionnaire construction, generating feedback on how easy the questionnaire is to complete and which concepts are unclear or out of the respondents' range of knowledge and/or responsibility (Flynn et al. 1990) After a first review and feedback from other researchers, the questionnaire was thoroughly tested in ten on-site interviews with general managers and representatives of German subsidiaries in China. Collins and Cordon (1997) note the need to “recognize differences in terminology between sectors and thus achieve a consistent interpretation of a question or questions when interviewing executives from a particular sector" (p.704). Therefore, to ensure a high degree of representativeness, the questionnaire was tested in companies from all five target industries. The feedback of these pre-tests uncovered some imprecise wording issues that were modified accordingly.

5.1.5 Data Collection Procedure

The data was collected as part of a research project on international expansion strategies with different research focuses. Considering the huge cost and the time

required for conducting such a large-scale, international survey, this procedure seems reasonable (see, e.g., Asmussen, Pedersen, and Dhanaraj 2009 for a similar approach).

Non-response represents a special challenge in international settings (see Harzing 1997). The survey followed an approach by Yip, Johansson, and Roos (1997) combining a questionnaire survey with personal interviews to get the necessary attention of senior management. This approach also is in accordance with Hoskisson et al. (2000), who recommend using face-to-face interviews instead of mail questionnaires for data collection in emerging economies to address issues related to both accessibility of respondents and reliability of responses. An attempt was made to have two interviewers present for all interviews, both of whom independently took notes, which were transcribed shortly after each interview. Because of the enormous demands of conducting more than 700 interviews with foreign affiliate heads in seven countries, several fellow researchers supported this project.

Diamantopoulos and Schlegelmilch (1996) point out that sponsorship by reputable organizations also positively affects response rates. Therefore, the German Chambers of Commerce in the target countries were contacted and asked for their sponsorship and support. Strongly interested in the research findings, which were provided in the form of presentations and publications, almost all the organizations contacted supported the research project. The following chambers and associations were involved in the research project: Camara de Comercio e Indúdtria Brasil-Alemanha, Delegation of German Industry and Commerce in Shanghai (GIC), German Industry Association in the Russian Federation, German Industry and Commerce Hanoi, German-Thai Chamber of Commerce (GTCC), Indo-German Chamber of Industry and Commerce (IGCC). These institutions provided infrastructure (workstation, phone, and Internet access) and contact information, as well as their respective logos or letterheads for a co-branding of the survey.

To motivate heads of subsidiaries to respond to the questionnaire, several measures

were taken: First, all recipients were offered incentives for their participation that included a summary report of the research project and comparison of their configuration strategy in relation to other companies in their industry and host country, as well as an invitation to the final presentation of results. Second, pre-notifications, intended to raise the awareness about the research project, were sent before mailing the questionnaire. Third, reminders were sent if recipients had not responded in a timely manner. Fourth, anonymity and confidentiality, which are regarded as key drivers of the response rate (see Diamantopoulos and Schlegelmilch 1996), were assured. The information obtained from the participating companies was considered strictly confidential. Survey results were communicated only in an aggregated way and without attribution to individual subsidiaries.

5.1.6 Sample Characteristics

During the process of data collection, 566 companies were contacted with a request for participation in the research project, resulting in 313 received questionnaires. Of those, 45 questionnaires were excluded because the self-reported industry affiliation deviated from the specified industry focus, because the self-reported equity shares were below 51%, or because respondents had skipped central questions. Consequently, 268 questionnaires could be included in the analysis, yielding an effective response rate of 47.3%. This result is extremely satisfactory, considering that typical top management survey response rates range between 15% and 20% (Menon, Bharadwaj, and Howell 1996; Reinartz, Krafft, and Hoyer 2004) . The high value achieved in the present study can be seen as the outcome of the chosen time- and resource-intensive data collection approach.

The industry distribution of the sample has been analyzed for representativeness using the chi-square goodness-of-fit test at a significance level of 5%. It revealed no difference in industry distribution between sample and parent population. The data on FDI provided by the German Central Bank (2008) was used as the basis for deriving

the expected frequencies of the parent population. Because the data do not differentiate between the chemical and pharmaceutical industries, these two industries had to be combined for the test.

Figure 5 shows further details of the sample characteristics. Regarding host countries, the sample is not equally distributed: ASEAN and India are more strongly represented. With regard to the equity modes, nearly three quarters of the surveyed managers lead a subsidiary that is wholly owned by the German parent company.

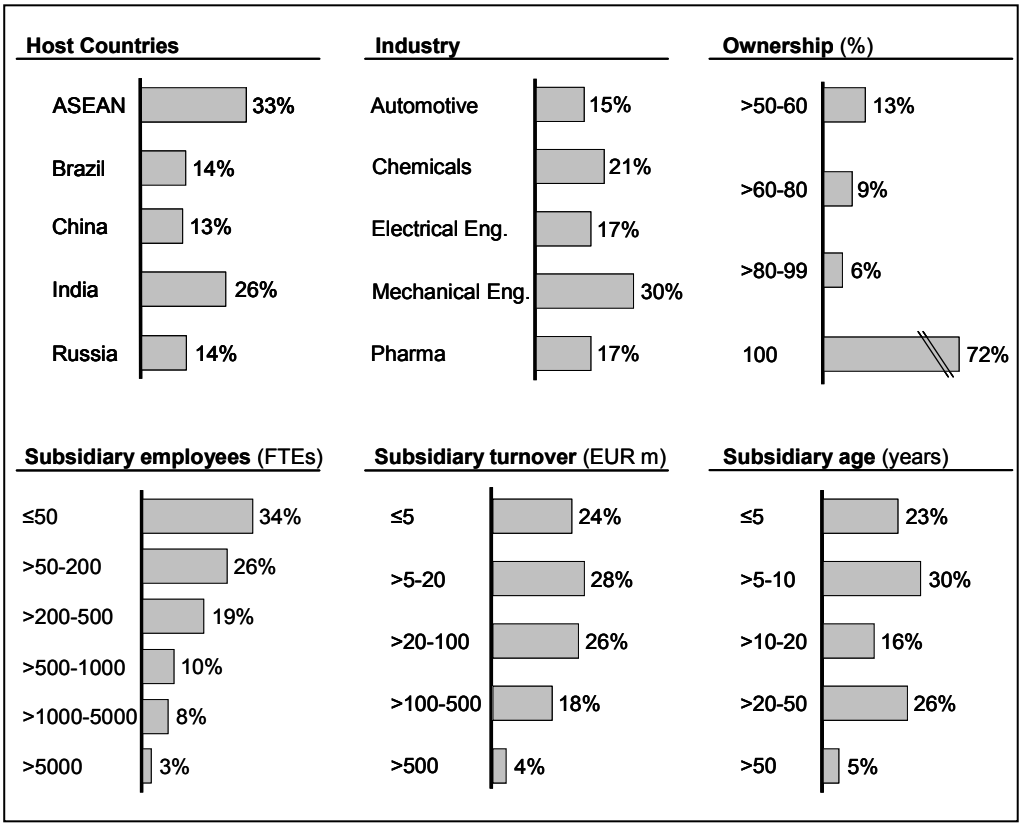


Figure 5: Sample Distribution By Context Factors

5.1.7 Data Attributes and Biases

According to Baumgartner and Homburg (1996), basic analysis of the raw data is often neglected when SEM is applied, including analysis of the distribution of variables, missing values, non-response bias, and key informant bias.

The dataset was tested for multivariate normality by the Kolmogorov-Smirnov test. The null hypothesis, assuming a multivariate normal distribution of the sample, had to be rejected for all variables. This is the case for most survey data (compare Lei and Lomax 2005; Scholderer and Balderjahn 2006). However, this result has consequences for the choices among statistical tests. Classical parametric tests typically require multivariate normal distribution of the sample. As the distribution of the present sample would violate this assumption, non-parametric tests were applied. These tests do not assume any specific distribution.

Item non-response occurs when questionnaires contain missing values for individual questions. Tsikriktsis (2005) has observed that many scholars do not properly treat these incomplete datasets. Following Kline (2004), there are three procedures for handling these missing values: deletion, imputation, and modeling their distribution. With the first one, the complete dataset is deleted; with the second one, the mean score for the missing item is calculated (mean imputation) or the score is generated by comparing the response to other datasets with similar patterns (hot-deck imputation); in the third procedure, modeling, a distribution is generated for the missing values. In the current sample, there is a maximum item non-response of less than 0.5%. This level is well below the threshold value of 10% applied by Tsikriktsis (2005, p.57). The low item non-response goes back to the described data collection procedure, which allows the researcher to insist on answers during the personal interview. Furthermore, missing values on subsidiary and MNE characteristics could be removed by manually looking up these data points in publicly available sources, such as annual reports and websites, or by making ex-post follow-up phone calls. For the treatment of the remaining missing values, the mean substitution method has been applied.

The test for non-response bias, or unit nonresponse, is necessary to determine significant differences in the (potential) answers between respondents and those who did not respond (Dillman et al. 2002). To examine whether there are systematic differences between the respondents and the non-respondents, Lambert and Harrington (1990) propose a procedure that compares the responses of early and late respondents, assuming the late respondents are a proxy for the non-respondents. Although there are no specific guidelines on the ideal proportions of the subsamples, the group of first respondents and the group of late respondents should be of equal size (see, e.g., Krause and Scannell 2002). If there are no significant differences between the two groups, it can be assumed that there is no non-response bias (Hudson et al. 2004). This procedure is not applicable, however, because of the setup of this study. The respondents were initially contacted at different times and hence had different amounts of time to answer after the initial contact. Therefore, each researcher had to evaluate the "difficulty to convince" for each respondent, approximating the resistance to answer even better than the "time to answer". This procedure is applicable only with personal interviews, but not with anonymous mail surveys. The non-parametric Mann-Whitney U-test was applied to analyze the current sample. As a result, only 8.9% of the variables showed significant differences at the 10% level, indicating that early and late respondents answer differently. There is no commonly accepted threshold value in literature; however, the current value does not exceed the significant level of the applied test. Therefore, it can be assumed that no non-response bias exists in the sample.

The key informant bias may be an issue when the respondent is not providing sufficient knowledge on the subject (Ernst 2003b). A query of multiple informants per subsidiary was not practicable in this research setting. However, several measures were applied to ensure an appropriate level of knowledge by the respondents: First, as mentioned, the survey for this study addressed the heads of foreign subsidiaries to maximize the validity of the collected data. Second, each respondent was asked to indicate his or her position in the company. Respondents who indicated a position other than president/vice president, general/senior manager, or representative were

eliminated from additional analysis. This process is regularly applied in empirical research (Kaufmann and Carter 2006). In the sample, 53% of the respondents indicated they were CEO or managing director, 35% president or vice president, and 10% representative. The remaining 2% indicated they were an assistant to one of the former positions. To ensure that the respondents were in fact qualified to answer the questions about the issues under investigation (see Kumar, Stern, and Anderson 1993), respondents were asked to indicate their experience with the industry, with leading a business unit, with the host country, and with strategic considerations. An average of 4.3, 4.1, 4.2, and 4.3 on a five-point Likert scale indicates substantial expert knowledge and experience in the respondents. Thus, it can be assumed that there is no key informant bias.

Since data on both the dependent and independent variables were collected from the same respondent, there might exist a common method bias. To address this issue, the study applied several remedies recommended in literature (see, e.g., Chang, Witteloostuijn, and Eden 2010; Podsakoff et al. 2003). Regarding the design and administration of the questionnaire, the respondents were assured of anonymity and condifentiality and informed that there are no correct or incorrect answers and that they should answer as honsetly as possible. Moreover, the items used in the present study are part of a large-scale questionnaire addressing aspects of internationalization beyond those used in this framework. This approach avoids that respondents combine related items to a cognitive map (Chang, Witteloostuijn, and Eden 2010) and makes it unlikely that "respondents would have been able to guess the purpose of the study and forced their answers to be consistent" (Mohr and Spekman 1994, p.147). Additionally, different scale anchors were applied for the independent variables. There were no direct question related to them; they were rather measured in an indirect way based on respondents' information on cross-border interdependencies of value creation (see Chapter 6.3). Besides these ex ante measures, an ex post Harman's single-factor test was run to address the common method bias. The results revealed that there was no general factor apparent in the factor structure (Podsakoff and Organ 1986). Hence, the design of the questionnaire and the post hoc test suggests that

common method bias is not an issue.

5.2 Data Analysis

This section describes the statistical methods applied for data analysis and outlines issues related to the assessment of the measurement and structural models with the respective fit criteria.

5.2.1 Statistical Methods for Data Analysis

SEM was chosen as the statistical method for data analysis. SEM has developed into a standard method for the investigation of complex causal relationships in economics, business, and social sciences (Bliemel et al. 2005, p.10). Contrary to the so-called “first generation” multivariate methods, SEM enables researchers to consider a set of interrelated research questions "in a single, systematic, and comprehensive analysis by modelling the relationships among multiple independent and dependent constructs simultaneously" (Gefen, Straub, and Boudreau 2000, pp.3-4). This thesis intends to test exactly this kind of model, with multiple constructs and several exogenous and endogenous variables. Furthermore, SEM enables more rigorous tests of formalized theories than conventional methods by incorporating measurement errors. This effect is achieved by differentiating between latent variables and manifest variables (Homburg and Dobratz 1998, p.450). SEM comprises both measurement models and a structural model. The measurement model relates the latent variable to its indicators. The structural model shows the relationship between endogenous and exogenous latent variables. Being able to assess a structural model and measurement models simultaneously, SEM constitutes an advanced combination of factor analysis and multivariate regressions.

SEM offers two alternative types of measurement models: reflective and formative ones. Conventional measurement practice in business research is based on reflective

measurement; however, the use of formative indicators as an alternative measurement approach recently has been gaining attention (see Diamantopoulos 2008). In reflective measurement models, indicators are representations of the construct. A latent construct thus causes or gives rise to the observed indicators (Fornell and Bookstein 1982). Reflective indicators are thus highly correlated and redundant because they are by definition caused by the same underlying reason (i.e., the construct). In reflective measurement models, measurement errors are considered at the indicator level because indicators generally do not perfectly reflect the underlying construct. In contrast, in formative measurement models, indicators form the construct. A latent construct is thus caused by the facets covered in its indicators (Bagozzi 1994). The observable indicators give rise to the latent construct (Fornell 1982). The construct is the linear sum of the items. Formative indicators should be defined in a mutually exclusive and collectively exhaustive way and thus do not necessarily correlate. In formative measurement models, measurement error is considered at the construct level because the lack of redundancy among the indicators does not allow a distinction between the "true" variance of the indicators and the measurement error.

Figure 6 (adapted from Götz and Liehr-Gobbers 2004, p.716) illustrates the two alternative measurement models, each with three indicators: ŋ represents the latent variable; x stands for the indicators; correlation between indicators is denoted by r; the strength of the relationship between the latent variable and its indicators is denoted in the case of the reflective measurement model by the loading λ and in the formative model by the weight π ; the residual values are denoted as δ on the indicator level and ζ on the latent variable level.

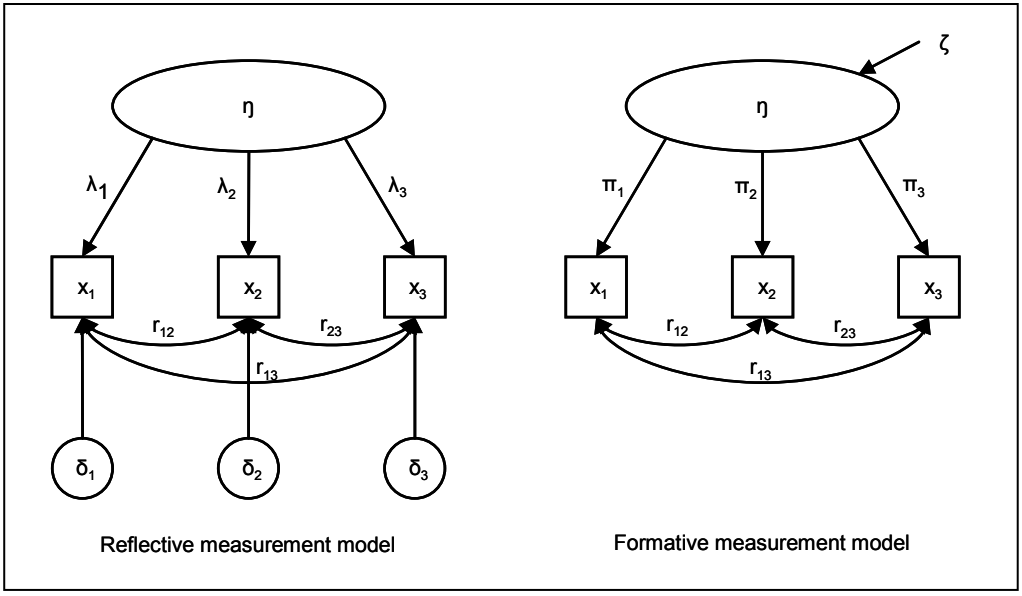


Figure 6: Reflective and Formative Measurement Models

The selection of the appropriate measurement model and the justification of the choice have been widely neglected (Fassott and Eggert 2005). Despite their "appropriateness in many cases" (Bollen 1989, p.65), formative measurement models have received relatively little attention (Fassott and Eggert 2005). More importantly, several studies (see, e.g., Podsakoff, Shen, and Podsakoff 2006, for a review of strategic management research) have shown that measurement models in empirical efforts are often misspecified because they assume a reflective structure when a formative approach should have been adopted. Diamantopoulos (2008) considers this to be "a result of researchers' (and reviewers') lack of familiarity with formative measurement models" (p.1201): Although an increasing number of methodological papers on formative measurement have appeared (e.g., Diamantopoulos and Siguaw 2006; Jarvis et al. 2003; MacKenzie, Podsakoff, and Jarvis 2005), the properties and advantages of formative measures are still not well understood. Already Cohen et al. (1990) showed in an analysis of 15 SEM models that a considerable number of constructs were

treated as reflective measurement models, although they were operationalized in a formative way. Diamantopoulos and Winkelhofer (2001) detected several empirical marketing studies with misspecified measurement models treating formative constructs in a reflective manner. Also, Jarvis et al. (2003) found in a review of leading marketing journals that almost one-third of the empirical studies suffer from misspecified measurement models, mainly because of an inappropriate treatment of formative constructs as reflective ones. Fassott and Eggert (2005) found in their analysis of German marketing journals misspecifications in more than 80% of the published studies. Similarly, Fassott (2006) showed that almost 60% of the constructs that were published in highly ranked German business research journals treated what were actually formative constructs with procedures for reflective constructs.

Yet the differentiation between the different types of measurement models is a crucial aspect. Misspecification may lead to redundancies, an elimination of essential indicators (Fassott 2006; Rossiter 2002, 2005), and distortions of parameter estimates (Albers and Hildebrandt 2006; Law and Wong 1999). Jarvis et al. (2003) conclude that a misspecification of the measurement model "severely biases structural parameter estimates and can lead to inappropriate conclusions about hypothesized relationships between constructs" (p.216). They even go one step further when stating that "a substantial proportion of the empirical results in the literature may be potentially misleading" (p.216). When analyzing the reasons for the numerous misspecifications, Fassott and Eggert (2005) argue with the standardization of evaluation criteria for reflective measurement models and the comparable lack of standards and software support to analyze formative measurement models. Similarly, Jarvis et al. (2003) find that researches are "forced into overreliance on reflective measurement model specifications by journal reviewers, who demand high internal consistency between measurement and unidimensionality as a condition for acceptance and publication" (p.213). Fassott (2006) also found that misspecification cannot in all cases be detected by commonly applied statistical fit criteria.

To determine the applicability of formative or reflective measurement models for this

study, the conceptual decision criteria established by Jarvis et al. (2003) were applied (see Table 5).The application of these test questions reveals that the predominant constructs conceptualized for this study are of a formative nature. (For details see Chapter 6 on the operationalization of the constructs).

Question	Formative	Reflective
Are the items a) defining characteristics or b) manifestations of the construct?	a)	b)
Would changes in the items cause changes in the construct?	Yes	No
Would changes in the construct cause changes in the items?	No	Yes
Do the items have the same or similar content or do they share a common theme?	Not necessarily	Yes
Would dropping one of the items alter the conceptual domain of the construct?	Possibly	No
Should a change in one of the items be associated with changes in the other items?	Not necessarily	Yes
Are the items expected to have the same antecedents and consequences?	Not necessarily	Yes

Table 5: Decision Rules for Differentiating Between Formative and Reflective Constructs

There is a distinction between covariance-based and variance-based model building techniques for SEM. The label of the two approaches also is often linked to the name of the respective software package that is used for the analysis. Thus, Linear Structural Relationships/LISREL, implemented by Karl Jöreskog (1970), and Analysis of Moment Structures/AMOS implemented by James Arbuckle, are synonyms for covariance-based SEM (see Homburg and Hildebrandt 1998). The variance-based technique is also known as the Partial Least Square/PLS approach, implemented by Herman Wold (1966). Regarding the use, the former approach dominates the latter,

yet, in recent yearls, the researchers' interest in PLS has increased condsiderably (see Reinartz, Haenlein, and Henseler 2009, p.333). The two methods mainly differ with regard to their estimation methods. Hence, differences arise with regard to the research objective, applicable measurement models, sample size and distribution requirements, and availability and calculation of fit criteria (see Chin and Newsted 1999; Jöreskog and Sörbom 1982; Ringle 2004; Scholderer and Balderjahn 2005, 2006). Neither of the approaches is regarded per se as superior to the other. Rather, they have to be considered as complementary rather than competitive methods (Jöreskog and Wold 1982). The choice of the most appropriate method thus depends on the research objective and setup of the study (Reinartz, Haenlein, and Henseler 2009; Scholderer and Balderjahn 2005).

For this thesis, the variance-based PLS approach is applied. A variance-based SEM is the preferable choice over the covariance-based methods because of the following three conditions that apply for this study: The model contains numerous formative measurement models, the model contains numerous indicators, and the data do not show a multivariate normal distribution (Chin 1998; Chin and Newsted 1999; Fornell and Bookstein 1982; Hulland 1999; Tenenhaus et al. 2005). The choice of PLS in the context of this study is also in line with literature that generally stipulates the use of PLS in cases of multiple formative indicators resulting from factor indeterminancy in covariance-based methods (see Herrmann, Huber, and Kressmann 2006; Shah and Goldstein 2006). For the selection of software packages, the recommendations provided by Temme and Kreis (2005) for variance-based techniques were used. Finally, SmartPLS 2.03 (Ringle, Wende, and Will 2005) was chosen as the most appropriate software.

5.2.2 Model Assessment

The extent to which an empirical investigation adequately describes reality mainly depends on the quality of the measurements (Backhaus et al. 2008). The evaluation

of the research model is a crucial task when estimating variance-based causal models (Ringle 2004). This study applies the two-step validation process for PLS models proposed by Götz and Liehr-Gobbers (2004) and Krafft, Götz, and Liehr-Gobbers (2005). In the first step, the measurement models are evaluated; in the second step the structural model is then analyzed.

Assessment of Measurement Models

For the assessment of measurement models, literature generally suggests testing three criteria: objectivity, reliability, and validity (see Berekoven, Eckert, and Ellenrieder 2006; Peter and Churchill 1986). However, formative measurement models must be evaluated differently from reflective ones (Bollen and Lennox 1991; Diamantopoulos and Winkelhofer 2001) because, in contrast to reflective indicators, formative indicators are not interchangeable, do not necessarily correlate, and have no error term (Claes and David 1981; Rossiter 2002). Thus, unidimensionality, indicator reliability, internal consistency, and discriminant validity are not meaningful for reflective measurement models because indices are formed as a linear sum of measurements (Bagozzi 1994; Fassott 2006; Krafft, Götz, and Liehr-Gobbers 2005). For the evaluation of the model, this study follows the established guidelines developed by Götz, Liehr-Gobbers, and Krafft (2010), Diamantopoulos and Winkelhofer (2001), and Fassott and Eggert (2005).

Objectivity of the data is given if the measurement is not subject to biases arising from the setup or the researcher (Nieschlag, Dichtl, and Hörschgen 2002). In this study, objectivity was ensured in survey execution by using a standardized written questionnaire. In interpretation, the use of close questions prevents any possible personal influence and thus ensures objectivity. In data analysis, objectivity is ensured by applying objective fit criteria for the assessment of the measurement and structural models.

Content validity describes the degree of semantic congruence between a construct and its indicators (Homburg and Giering 1996). For formative measurement models,

content validity has to be ensured ex-ante when specifying the indicators (Bollen and Lennox 1991; Nunnally 1978; Rossiter 2002; Wacker 2004). The present study followed the procedure recommended by Fassott and Eggert (2005) to ensure content validity using a thorough definition of the theoretical construct and its indicators. This approach is in line with Peter and Churchill (1986), who conclude in a meta-analysis of fit criteria that "researchers must pay greater attention to non-empirical evidence when judging construct validity" (p.1). Furthermore, the test for formative content validity stipulated by Anderson and Gerbing (1991) was applied. This approach is similar to the Q-methodology, a research method established in psychology and related social sciences (see Carter, Kaufmann, and Michel 2007, p.643 et seq.). Based on expert judgments, two indices are calculated. The proportion of substantive agreement p_{sa} measures the unambiguousness of the indicator attribution. The coefficient of substantive validity c_{sv} measures the relevance of a construct. The indices are calculated as follows:

$$P_{sa} = \frac{n_c}{N} \qquad c_{sv} = \frac{n_c - n_0}{N}$$

where
n_c = number of "correct" attributions
n_0 = number of identical "wrong" classifications
N = number of surveyed experts

The value for the proportion of substantive agreement should exceed the minimum threshold value of 0.5. The coefficient of substantive validity should exceed zero. For the present study, the indices have been calculated on the basis of the judgment of twelve experts.

Instead of using indicator reliability, which for formative constructs captures the individual indicator's variance proportion explained by the underlying construct, Götz and

Liehr-Gobbers (2004) and Krafft, Götz, and Liehr-Gobbers (2005) recommend testing for *indicator relevance* – an analysis of the contribution of each individual indicator to the construct. The weight of the formative indicator provides information about the relative importance of each of the construct's indicators (Chin 1998). Significance of the indicator weight was analyzed on a 0.1%, 1%, 5%, and 10% significance level. The standard deviation derived from a bootstrapping re-sampling procedure allows a t-test. A one-tailed analysis was conducted because the direction of the relationship between the indicator and the construct is specified. In contrast to reflective measurement models, where a low value for loadings implies a poor measurement model, low values for indicator weights in formative measurement models do not allow any inference on the quality of the measurement model (Chin 1998). The elimination of indicators with low weight may harm the substance of the construct or omit part of the construct (Bollen and Lennox 1991; Diamantopoulos and Winkelhofer 2001; Götz and Liehr-Gobbers 2004; Jarvis et al. 2003). To avoid "model trimming" for formative constructs, Hermann, Huber, and Kressmann (2006) and Helm (2005) recommend that researchers not apply specific threshold values for indicator elimination. This study followed the recommendations by Law and Wong (1999) to retain insignificant indicators in the measurement model. Thus, only indicators with reverse signs are eliminated; indicators with only marginal contribution to the construct's variance are kept to ensure the theoretical substance of the construct (Jarvis et al. 2003).

Multicollinearity between indicators may pose a problem for formative constructs because the measurement is based on multiple regression analysis. Substantive item intercorrelations, and thus increasing standard errors of beta coefficients, make it difficult to separate the distinctive influence of individual indicators, negatively affect the stability of weights (Diamantopoulos and Winkelhofer 2001), and lead to unreliable parameter estimates (Backhaus et al. 2008). This study applied the comprehensive four-step approach developed by Krafft et al. (2005), including several measures in order to test for multicollinearity in formative constructs. The *highest pairwise correlation* (r_{max}) must not exceed the threshold of +/- 0.9. Otherwise, one of the corresponding items has to be eliminated based on conceptual considerations (see Diaman-

topoulos and Winkelhofer 2001; p.273). To test for multicollinearity between more than two indicators, linear ancillary regression is performed for each indicator, testing to what extent the variance of an indicator can be explained by the remaining indicators. The *variance inflation factor* (VIF) is defined as the reciprocal of the tolerance 1-R^2 (Eckey, Kosfeld, and Dreger 2004). VIF reaches a minimum of 1 when the indicators are completely independent. The threshold value is defined as 10, which should not be exceeded (Diamantopoulos and Winkelhofer 2001; Götz, Liehr-Gobbers, and Krafft 2010) Furthermore, the *maximal condition index* (CI_{max}) is applied to test for multicollinearity, and its value should be below 30 (Krafft, Götz, and Liehr-Gobbers 2005). Finally, variance decomposition was conducted to evaluate the variance proportion of the individual regression coefficients explained by the condition indices (Belsley, Kuh, and Welsch 2004). The value of the *second highest variance decomposition proportion of a component* (VDP_{2nd}) should not exceed 0.9.

Because construct reliability is not a valid test for formative measurement models, this study applied the alternative test for *nomological validity* of formative constructs, proposed by Reinartz, Krafft, and Hoyer (2004). Nomological validity is given when hypothesized relations behave as expected (Bagozzi and Phillips 1982; Peter and Churchill 1986) and is tested by empirically measuring the significance, strength, and direction of the relationship between constructs in the structural model (Götz and Liehr-Gobbers 2004). This test is performed in the context of the structural model analysis.

Table 6 summarizes the described test criteria.

Assessment of Second-Order Constructs

To capture different aspects, constructs might be structured in a hierachical way (Homburg and Giering 1996). In this study, market opportunities and economies of location are operationalized as second-order constructs, each comprising two first-order constructs. The repeated indicator approach suggested by Wold (1982) was applied in order to model the second-order constructs in PLS. The assessment of the

measurement model is then conducted in two steps: First, the measurement models of the first-order constructs are tested. Second, the measurement models of the second-order constructs are evaluated, interpreting the first-order constructs as indicators of the second-order construct.

Fit criteria	Measure	Variable	Level	Threshold value
Convergent validity	Proportion of substantive agreement	p_{sa}	Item	≥ 0.5
	Coefficient of substantive valdity	c_{sv}	Item	› 0
Indicator relevance	Weight	π	Path	n.a.
	t-value	t	Path	(≥ 1.28)
	Significance of weight	α	Path	(10%, one-tailed)
	Sign	n.a.	Path	Right direction
Multi-collinearity	Highest pairwise correlation	r_{max}	Item	$-0.9 \leq r_{max} \leq 0.9$
	Variance inflation factor	VIF	Item	≤ 10
	Highest condition index	CI_{max}	Construct	≤ 30
	2nd highest variance-decomposition proportion per component	VDP_{2nd}	Construct	≤ 0.9
Nomological validity	Check for nomological relationships in structural model	n.a.	Structural model	5% (10%), one-tailed

Table 6: Fit Criteria for Formative Measurement Models

Assessment of Structural Models

For the evaluation of the structural model, the current study follows Krafft, Götz, and Liehr-Gobbers (2005) and tests for strength, explanatory power, and predictive validity of structural relationships.

Path coefficients in SEM give information about the *relationship strength* between exogenous and endogenous constructs. Path coefficients can be analyzed for sign, strength, and significance (Chin 1998). The significance of path coefficients is calculated by applying the bootstrap resampling procedure and subsequent one-sided t-test. Lohmöller (1989) identifies path coefficients of 0.1 as sufficient. Goerzen and Beamish (2003) emphasize that path coefficients smaller than 0.1 can confirm hypotheses, as long as the relationship is statistically significant. In the present study, a hypothesis is supported if the path coefficient shows the expected sign and is significantly different from zero. Because of a systematic underestimation of path estimation (Anderson and Gerbing 1991; Chin, Marcolin, and Newsted 2003; Dijkstra 1983), PLS estimates are regarded as "conservative", preventing insignificant relationships from appearing to be significant.

Explanatory power is generally measured by the coefficient of determination, R^2, indicating the goodness of fit between the model and the data with respect to the explained variance. Chin (1998) defines R^2 values of larger than 0.66 as substantial, of 0.33 as average, and of below 0.19 as weak. However, there is no universally valid threshold that applies to all models and research contexts (Backhaus et al. 2008; Homburg and Baumgartner 1998). With regard to empirical marketing research in an emerging market context, Burgess and Steenkamp (2006) recently appealed for applying more liberal criteria, rather than "more or less blindly" (p.349) adapting common interpretations of threshold values used in Western contexts. In addition to the explanatory power on the endogenous construct level, the effect size f^2 measures the relative change in R^2 on the structural path level. Cohen (1988) defines f^2 values of 0.35 as substantial, of 0.15 as moderate, and of 0.02 as weak. However, Chin, Marcolin, and Newsted (2003) relativizes this classification and states that small f^2 values

do not necessarily imply an unimportant effect. Referring to Rosenthal (1991), Burgess and Steenkamp (2006) argue that even if an effect size may not seem large, it can represent a substantial effect.

Multicollinearity is assessed at the construct level, based on the correlation matrix of the latent variables. As with the test of multicollinearity for measurement models, the highest pairwise correlation rmax should not exceed the threshold value of +/- 0.9.

Table 7 summarizes the described test criteria for structural relationships.

Fit criteria	Measure	Variable	Level	Threshold value
Strength of relationship	Path coefficients	γ	Path	(≥ 0.1)
	t-value	t	Path	≥ 1.28
	Significance of path coefficient	α	Path	10%, one-tailed
	Sign	n.a.	Path	Right direction
Explanatory power	Coefficient of determination	R^2	Endogenous construct	≥ 0.2
	Effect size	f^2	Path	(≥ 0.02)
Multi-collinearity	Highest pairwise correlation	r_{max}	Construct	$-0.9 \leq r_{max} \leq 0.9$

Table 7: Fit Criteria for Structural Models

5.2.3 Subgroup Analysis

The analysis of moderating effects has gained increasing importance in the social sciences (see Hall and Rosenthal 1991), particularly in studies building on contingency perspective that analyze outcomes in different situational settings (McKeen,

Guimaraes, and Wetherbe 1994; Weill and Olson 1989). There are two basic techniques to test for moderating effects: subgroup analysis and moderated regression analysis (Venkatraman 1989). In this study, subgroup analysis is used to investigate differences in R&D configuration in different contexts and over time. Because the applied software package does not allow for subgroup analysis, the necessary calculations were performed separately. Subgroups based on categorial variables, such as industry, host country, and time (present vs. future), were defined according to their grouping variables (Henseler and Fassott 2008). For continuous variables, the subgroups were dichotomized into two categories at the median. This approach was applied for subsidiary and MNE characteristics, such as age, number of employees, and turnover.

To test for significance of differences in average values between subgroups, non-parametric tests were applied because the Kolmogorov-Smirnov test showed that the variables do not follow a multivariate normal distribution. The Mann-Whitney U test (Mann and Whitney 1947) is a non-parametric equivalent to the independent samples t-test. In the study at hand, it is applied in dichotomous subgroup analysis and when comparing individual subsample values to total sample values. The Kruskal-Wallis one-way analysis of variance by ranks (Kruskal and Wallis 1952) allows for the assessment of differences between more than two independent samples. In this study, it is used to assess differences between subgroups with regard to R&D configuration. The Wilkoxon signed-rank test (Wilcoxon 1945) represents a non-parametric equivalent to the paired t-test. It is applied in cases where there are two related samples. In this study, it is used to examine the significance of time-related differences in subsidiary R&D configurations.

6 Conceptualization and Operationalization of Constructs

This chapter introduces the measurement model for the constructs of the research framework. Bagozzi and Fornell (1982) define a theoretical construct as an “abstract entity which represents the ‘true,’ non-observable state or nature of phenomenon” (p.24). Thus, these constructs initially have to be made tangible by manifest variables that serve as indicators for the not directly oberservable latent variable representing the construct. Conceptualization thereby refers to the development of the construct dimensions, whereas operationalization refers to the subsequent development of a measurement instrument for the construct (see Homburg and Giering 1996, p.5).

We attempted to use existing and proven scales in IB research whenever possible. Because this study aims to cover a substantial range of previously discussed aspects of the business environment and to analyze the degree to which they actually influence the configuration of subsidiary-level R&D activities, the conceptualization of location-specific features builds on the international sources of competitive advantage derived by Panhans (2009), based on an extensive review of existing literature on internalization motives. These scales are particularly appropriate for this study because of the comprehensiveness of the constructs and corresponding indicator variables. The discussion in the following subchapters focuses on the conceptualization of the constructs and the evaluation of the measurement models.

For the operationalization of the formative constructs, we follow the established three-step approach suggested by Diamantopoulos and Winkelhofer (2001, pp.271-274). In the first step, the content of the latent variable is specified. In the second step, formative indicators are selected based on theoretical considerations. This grouping should comprise all indicators that are expected to have an influence on the construct. Having specified the content and indicators of the constructs, the measurement models are evaluated based on the criteria described in Chapter 5.

The two constructs, “Market Opportunities” and “Economies of Location” represent

second-order constructs, each comprising two first-order constructs. For these second-order constructs, the same validation methods apply as for first-order constructs, with the first-order constructs serving as indicators for the second-order construct. Second-order constructs were used because they are able to cover a broad range of aspects, of different dimensions, within a single construct. Values for evaluating the content validity of the second-order constructs are gained by averaging the p_{sa}-values and c_{sv}-values from the first-order construct level. Multicollinearity is assessed using the highest pair-wise correlation r_{max}. Tests for variance inflation factor (VIF) and highest condition index (CI_{max}) cannot be applied for second-order constructs consisting of less than three first-order constructs. Indicator relevance is assessed on the basis of the weights, significance levels, and signs of the first-order construct.

6.1 Dimension A: Location-Based Features

The location-based or host economy-specific features (see Enright 2009) summarized in dimension A are exogenous, independent variables and comprise market opportunities, economies of location, and cultural distance. The first two represent internationalization motives regarding the host countries' sales and factor market. Each of the motives is operationalized as a formative second-order construct. Cultural distance represents a major source of informational and communication complexity and thus an important internationalization hurdle.

6.1.1 Market Opportunities

Market opportunities describe the various benefits gathered from foreign sales markets. This driver is measured as a second-order construct consisting of the two complementary aspects, "demand-based market opportunities" on the one hand and "competition-based market opportunities" on the other. Demand-based opportunities are customer-related whereas competition-based opportunities are primarily supply-related.

		Content validity		Multicollinearity		Indicator relevance			
2nd order construct level		p_{sa}	c_{sv}	CI_{max}	VDP_{2nd}				
		0.93	0.85	n.a.	n.a.				
Item level		p_{sa}	C_{sv}	r_{max}	VIF	π	t	α	sign
MoC	Competition-based market opportunities	0.90	0.79	-0.58	n.a.	0.51	8.04	***	✓
MoD	Demand-based market opportunities	0.96	0.92	-0.58	n.a.	0.61	11.01	***	✓

Table 8: Fit Criteria of the Second-Order Construct "Market Opportunities"

The results for the second-order construct "market opportunities" are shown in Table 8. All fit criteria satisfactorily meet the specified cutoff values. Content validity of both factors is high. Values of 0.93 for the proportion of substantive agreement p_{sa} and 0.85 for the coefficient of substantive validity c_{sv} indicate substantial consensus among the experts on the attribution of the items to the respective construct. Multlicollinearity also does not pose an issue. The correlation coefficient of -0.58 is far below the specified threshold of +/-0.9. The negative sign stands for a negative relationship between both first-order factors, meaning that with greater demand-based market opportunities, competition intensity in the respective market increases. Indicator relevance is given for both first-order factors because both weights are significantly different from zero at the 0.1% level and have the expected sign. The higher weight for demand-based market opportunities suggests a slightly higher relevance of demand aspects compared to competitive aspects. In the following paragraphs, the two first-order measurement models are evaluated.

Competition-based market opportunities include: 1) the exploitation of low competition intensity (Anand and Kogut 1997; Buckley and Castro 2001; Porter 1980; Sullivan and Bauerschmidt 1990); 2) the exploitation of a low threat of substitutes (Porter 1980; Prahalad and Doz 1987); 3) the exploitation of core competencies against weaker local competitors (Forsgren 2002; Lall and Siddharthan 1982); 4) the protection of the host market from international competitors (Bass, McGregor, and Walters 1977; Dunning and McKaig-Berliner 2002; Kogut 1988; Sullivan and Bauerschmidt

1990; Terpstra and Chwo-Ming 1988); 5) the attack of local competitors in their home market (Buckley and Castro 2001; Hamel and Prahalad 1985); and 6) gaining first mover advantage in market penetration (Hout, Porter, and Rudden 1982; Kim and Hwang 1992; Kogut 1988).

		Content validity		Multicollinearity		Indicator relevance			
Construct level		p_{sa}	c_{sv}	CI_{max}	VDP_{2nd}				
		0.90	0.79	8.24	0.32				
Item level		P_{sa}	C_{sv}	r_{max}	VIF	π	t	α	sign
MoC.1	Exploiting low competition intensity	1.00	1.00	-0.24	1.16	0.35	2.35	**	✓
MoC.2	Exploiting low threat of substitutes	eliminated							
MoC.3	Exploiting core competencies against weaker local competitors	0.83	0.67	-0.26	1.16	0.14	1.46	†	✓
MoC.4	Defending host market from international competitors	0.75	0.50	-0.26	1.25	0.10	0.87	n.s.	✓
MoC.5	Attacking local competitors in their home market	eliminated							
MoC.6	Gaining first mover advantage in market penetration	1.00	1.00	-0.24	1.22	0.49	4.77	***	✓

Table 9: Fit Criteria of the Construct "Competition-Based Market Opportunities"

The construct was operationalized using six indicator variables, two of which had to be eliminated because of reverse signs (see Table 9). For the remaining items, content validity is high, with p_{sa} and c_{sv} values of 0.9 and 0.79, respectively. With regard to indicator relevance, defending the host market from international competitors did not significantly contribute to the overall construct. However, this item was retained because there is no general recommendation in the extant literature to eliminate insignificant indicators. Rather, the literature refers to content-based aspects (see Diamantopoulos and Winkelhofer 2001, p.273; Krafft, Götz, and Liehr-Gobbers 2005, p.78). The elimination of MoC.5 (attacking local competitors) and the low item weight of MoC.4 (defending host market) are in contrast to previous empirical literature, which reports significant relationships for the opportunities to defend a host market from international competitors and to attack foreign competitors in their home market (e.g., Flowers 1976; Graham 1978; Knickerbocker 1973). However, this literature

builds on the oligopolistic parallel behavior theory and therefore mainly refers to oligopolistic industries. The fact that this study did not focus on industries with an oligopolistic type of market might explain the lack of contribution of these two items. Gaining first-mover advantage in market penetration (MoC.6) and exploiting low competition intensity (MoC.1) contribute most to competition-based market opportunities, but the exploitation of core competencies against local competitors (MoC.3) also significantly contributes to the construct. This finding is particularly interesting because, in existing literature, these aspects attracted little research attention and were mainly subject to conceptual considerations. Multicollinearity does not constitute a problem at either the item or the construct level. The values of the highest pair-wise correlation r_{max} are substantially below the cutoff values for all indicators. Also, the VIF, testing multicollinearity between more than two items, remains far below the specified threshold value of 10. At the construct level, the highest condition index and the second highest variance-decomposition proportion per component fall considerably below the cutoff values of 30 and 0.9, respectively.

In addition to competition-related aspects, demand-related aspects constitute market opportunities. Demand-based market opportunities comprise: 1) exploitation of foreign market size (Buckley and Dunning 1976; Enright 2009; Hakanson 1992; Hakanson and Nobel 1993a, 1993b; Hegde and Hicks 2008; Kuemmerle 1999a; Kumar 2000a, 2001; Le Bas and Sierra 2002); 2) exploitation of foreign market growth (Anand and Kogut 1997; Buckley and Castro 2001; Dunning 1980; Veugelers 1991); 3) exploitation of low buyer negotiation power (Porter 1980); 4) reduction of demand risk (Jarillo and Martinez 1991; Mascarenhas 1982); 5) selling of older technology in less sophisticated markets (Doz 1986; Hirsch 1967; Mansfield, Teece, and Romeo 1980; Vernon 1966); 6) following existing key customers to the host market (Buckley and Castro 2001; Erramilli and Rao 1990); 7) gaining access to sophisticated local lead customers (De Meyer 1992; Florida and Kenney 1994; Gerybadze and Reger 1999; Gupta, Govindarajan, and Wang 2008); and 8) gaining reputation in existing markets by selling to the host country (Jarillo and Martinez 1991).

		Content validity		Multicollinearity		Indicator relevance			
Construct level		p_{sa}	c_{sv}	CI_{max}	VDP_{2nd}				
		0.96	0.92	14.19	0.55				
Item level		p_{sa}	C_{sv}	r_{max}	VIF	π	t	α	sign
MoD.1	Exploiting market size	1.00	1.00	-0.33	1.24	0.07	0.91	n.s.	✓
MoD.2	Exploiting high market growth	1.00	1.00	-0.33	1.17	0.51	4.15	***	✓
MoD.3	Exploiting low negotiation power of buyers	eliminated							
MoD.4	Reducing demand risk	eliminated							
MoD.5	Selling older technology in less sophisticated market	0.92	0.83	-0.11	1.06	0.29	2.79	**	✓
MoD.6	Following existing key customers to host country	0.92	0.83	-0.27	1.23	0.26	2.25	*	✓
MoD.7	Accessing sophisticated local lead customers	1.00	1.00	-0.28	1.36	0.06	0.62	n.s.	✓
MoD.8	Gaining reputation in existing markets by selling to host	0.92	0.83	-0.28	1.30	0.19	2.25	*	✓

Table 10: Fit Criteria of the Construct "Demand-Based Market Opportunities"

Overall, the measurement of "market opportunities" is very satisfactory. Particularly taking into consideration that, in contrast to market-based aspects, competition-related market opportunities have thus far received considerably less attention in empirical research, the indicators of the construct show a good model fit.

6.1.2 Economies of Location

Economies of location relate to advantages gained on foreign factor markets. Thus, they represent the comparative advantages of nations that are distinct from firm-specific competitive advantages. Kogut (1985a) notes that the exploitation of comparative advantages of nations, such as lower factor costs or higher factor quality, may lead to firm-specific competitive advantages. Thus, firms can benefit from a host country's economies of location by "configuring its value-chain so that each activity is located in the country which has the least cost for the factor that the activity uses most intensely" (Ghoshal 1987, p.432). This observation means that economies of

location unfold their full potential and translate into a competitive advantage if they are transferred across borders (Dunning 1998, p.60; Porter 1986a, p.37). Ghemawat (Ghemawat 2003) denotes this "exploitation of differences in the price of an asset, product, or factor of production between markets" (Kogut 1985a, p.34) as the "arbitrage function" of a firm.

Referring to Porter (1986b), economies of location are differentiated into "lower factor cost" and "higher factor quality". These two first-order constructs form the second-order construct, "economies of location" (see Table 11).

		Content validity		Multicollinearity		Indicator relevance			
2nd order construct level		p_{sa}	c_{sv}	CI_{max}	VDP_{2nd}				
		0.94	0.89	n.a.	n.a.				
Item level		p_{sa}	C_{sv}	r_{max}	VIF	π	t	α	sign
EIC	Factor costs	0.92	0.83	-0.34	n.a.	0.56	7.40	***	✓
EIQ	Factor quality	0.97	0.94	-0.34	n.a.	0.63	10.09	***	✓

Table 11: Fit Criteria of the Second-Order Construct "Economies of Location"

Content validity of both first-order factors is high, with values for the proportion of substantive agreement and coefficient of substantive validity at the construct level of 0.94 and 0.89, respectively. Indicated by a relatively low value for the highest pair-wise correlation of -0.34, multicollinearity is not an issue. The negative correlation between the factors exhibits a certain substitutive effect between factor costs and factor quality (i.e., higher factor quality goes along with increased costs). Additional tests for multicollinearity were not carried out on the second-order construct level because at least three items are necessary for the calculation. Thus, these tests are applied on first-order construct levels. Indicator relevance is high, with both factors being significantly different from zero at the 0.1% level. However, it is remarkable that the factor quality ($\pi = 0.63$) is considered slightly more important than factor costs ($\pi = 0.57$). In the following paragraphs, the two first-order measurement models are evaluated.

Economies of location linked to attractive factor costs include: 1) exploitation of low labor costs (Edler 2008; Kogut 1985b; Kumar 2001; Lu and Liu 2004; Papanastassiou and Pearce 1994a); 2) exploitation of low property costs (Bass, McGregor, and Walters 1977; Zhao and Zhu 2000); 3) better access to capital (Ajami and BarNiv 1984; Ajami and Ricks 1981); and 4) profit from low tax levels (Barry 2005; Cantwell and Mudambi 2000, 2005; de Mooij and Ederveen 2003; Enright 2009; Hall and Reenen 2000; Kogut 1985b).

Table 12 shows the results of the first-order construct, "factor costs", which has been operationalized by four indicators. Because of a negative weight sign, the item "lower tax level" (EIC.4) had to be eliminated. This result is in contrast to studies that propose the positive effect of tax credits as a competitive advantage and driver for R&D activities (e.g., Hall and Reenen 2000). However, extant literature is not unambiguous with regard to the effect of tax incentives on R&D configuration: Cantwell and Mudambi (2000), for instance, provided evidence for only an incremental positive effect of tax credits encouraging subsidiaries to expand their existing technological role in the corporate R&D network. Cantwell and Mudambi (2005) even found empirical evidence that such government incentives can, depending on the mandate of the foreign affiliate, even have a negative effect on the subsidiary's R&D intensity. Moreover, difficulties in measuring tax incentives might also be a reason for the result that calls for the elimination of the item. For R&D efforts, depreciation allowances might be a more important cost driver than a country's absolute tax level.

For the remaining three indicators, content validity is generally high. Two items reach maximum values. Only better access to capital (EIC.3) was regarded as belonging to market opportunities or economies of scope by some of the experts. However, the content validity indices for this item still stay well above their minimum threshold values. The item thus is retained in the measurement model. Multicollinearity does not pose an issue. The variance inflation factor is well below the threshold value, and pair-wise correlations are at acceptable levels. Labor and property costs interestingly show a negative relationship, indicating a substitution effect between these two fac-

tors. At the construct level, both indicators of multicollinearity show good results. In terms of indicator relevance, two items significantly contribute to the overall construct. With a weight of 0.62, labor costs (EIC.1) are by far the most important aspect of factor cost advantages. This result might be explained by the high labor intensity of R&D activities. The same holds for the insignificance of lower property costs (EIC.2), which are of only minor importance because this item does not significantly contribute to the construct.

		Content validity		Multicollinearity		Indicator relevance			
Construct level		p_{sa}	c_{sv}	CI_{max}	VDP_{2nd}				
		0.92	0.83	8.96	0.17				
Item level		p_{sa}	C_{sv}	r_{max}	VIF	π	t	α	sign
EIC.1	Labor costs	1.00	1.00	-0.47	1.29	0.62	3.46	***	✓
EIC.2	Property costs	1.00	1.00	-0.47	1.50	0.22	1.28	n.s.	✓
EIC.3	Access to capital	0.75	0.50	-0.40	1.20	0.28	1.38	†	✓
EIC.4	Tax level	eliminated							

Table 12: Fit Criteria of the Construct, "Factor Costs"

The construct "factor quality" in the host country includes: 1) high employee qualification (Dunning 1980; Florida 1997; Hegde and Hicks 2008; Iwasa and Odagiri 2004; Kuemmerle 1999a; Kumar 2001; Lewin, Massini, and Peeters 2009); 2) few regulations (Siddharthan and Kumar 1990); 3) host government incentives (Cantwell and Mudambi 2000; Green and Cunningham 1975; Hakanson and Nobel 1993a; Kumar 2000a; Papanastassiou and Pearce 1994a; Robson 1993; Zhou, Delios, and Yang 2002); 4) high technological know-how and innovative activities (Andersson and Forsgren 2000; Brouthers and Brouthers 1997; Cantwell 1989; Cantwell and Janne 1999; Dunning 1980, 1995; Florida 1997; Hegde and Hicks 2008; Iwasa and Odagiri 2004; Kim and Lyn 1987; Kuemmerle 1999b; Kumar 2001; Odagiri and Yasuda 1996; Papanastassiou and Pearce 1994b; Song and Shin 2008; Wesson 1993); 5) externalities from agglomeration and spillovers (Almeida and Phene 2004; Branstetter 2006; Feinberg and Gupta 2004; Kumar 2001; Love 2003; Patel and Vega 1999; Pearson,

Brockhoff, and Boehmer 1993; Sanna-Randaccio and Veugelers 2007); 6) proximity to natural resources (Ajami and Ricks 1981; Kumar 1998; Root and Ahmed 1978); and 7) proximity to suppliers (Ajami and Ricks 1981; Belderbos 2001; Chen 2007; Davis and Meyer 2004; Dunning and McKaig-Berliner 2002).

		Content validity		Multicollinearity		Indicator relevance			
Construct level		p_{sa}	c_{sv}	CI_{max}	VDP_{2nd}				
		0.97	0.94	7.18	0.25				
Item level		p_{sa}	C_{sv}	r_{max}	VIF	π	t	α	sign
EIQ.1	Employee qualification	1.00	1.00	-0.49	1.37	0.71	5.25	***	✓
EIQ.2	Fewer regulations	eliminated							
EIQ.3	Host government incentives	0.92	0.83	-0.35	1.18	0.27	1.85	*	✓
EIQ.4	Technological know-how	1.00	1.00	-0.49	1.56	0.11	0.73	n.s.	✓
EIQ.5	Externalities from agglomeration (i.e., spillovers)	eliminated							
EIQ.6	Proximity to natural resources	eliminated							
EIQ.7	Proximity to suppliers	eliminated							

Table 13: Fit Criteria of the Construct "Factor Quality"

Table 13 depicts the findings for "factor quality". The construct was operationalized with seven items, four of which had to be eliminated because of negative weight signs. Fewer regulations (EIQ.2), externalities from agglomeration (EIQ.5), proximity to natural resources (EIQ.6), and proximity to suppliers (EIQ.7), as surveyed in this study, do not seem to be part of the economies of location. The focus on manufacturing industries might explain the low relevance of natural resources (see Panhans 2008 and Breitschwerdt 2008, who come to a similar conclusion). In the existing literature, there is very little empirical evidence showing the effect of fewer regulations on international configuration. Externalities from agglomeration, however, have received considerable research attention. In the context of R&D, externalities occur by accessing clusters of scientific excellence, so-called "pockets of innovation". The unexpected result of EIQ.5 indicates that these spillovers from the local environment do not (yet) play a major role in emerging countries. The reasonmight be that cutting-

edge know-how for particular trendsetting technologies is often concentrated in geographically limited centers, which are generally located in developed countries (Ambos and Ambos 2009a). The same holds for the supply base. Furthermore, the role of clusters as drivers of knowledge- or resource-seeking investment is not without controversy. A number of recent studies argue that local competitive interaction in clusters might offset the potential attraction of knowledge spillovers (Aharonson, Baum, and Feldman 2007; Alcácer 2006; Alcácer and Chung 2007; Chung and Kalnins 2001; Shaver and Flyer 2000). Clusters in local networks might suffer from the problem of adverse selection because technological leaders have more to lose from knowledge leakages than they have to gain from knowledge spillovers (Cantwell 2009). The unexpected result of ElQ.7 indicates that local suppliers in emerging countries are still not seen as an important source of innovation. Moreover, this result is consistent with recent empirical evidence finding that under conditions in which quality of supply is high, subsidiaries do not show a higher degree of R&D activities (Davis and Meyer 2004). For the remaining three items, content validity is high. Multicollinearity does not pose an issue. All indices stay far below the critical threshold value. The negative pair-wise correlations indicate a certain substitutive effect, indicating that firms are mainly driven by one of the three factors, whereas government incentives might compensate for some less favorable conditions (see also DuBois, Toyne, and Oliff 1993).

The evaluation of indicator relevance shows that ElQ.4 has no significant weight, which is not surprising in the context of emerging economies. ElQ.1 and ElQ.3 are significantly different from zero at the 0.1% and 5% level, respectively. In particular, employee qualification contributes to the quality of factor endowments of the respective host country. However, the results also show the important role of government incentives.

Overall, the measurement of the construct “economies of location” is satisfactory, representing a valid construct for further use in the structural model.

6.1.3 Cultural Distance

Cultural distance is generally defined as differences in values and beliefs between home and host countries. The seminal work of Hofstede (1980) distinguishes between four dimensions of cultural differences: power distance, individualism, uncertainty avoidance, and masculinity. Power distance reflects the extent to which members of an institution or organization expect and accept differences in power distribution. Individualism focuses on the relationship between the individual and groups. It measures the level of emphasis given to encouraging individuality and uniqueness in contrast to conformity and interdependence. Uncertainty avoidance describes the way cultures cope with uncertainty and ambiguity and adapt to changes. Cultures with high uncertainty avoidance feel threatened about uncertainty and prefer instructions, rules, and regulations. Masculinity reflects the extent to which a society emphasizes distinct gender roles. In masculine cultures, men are expected to be competitive, assertive, and focused on material success whereas women are supposed to be more relationship-oriented, modest, and concerned with the quality of life. In less masculine cultures, social gender roles are more fluid and overlap. Kogut and Singh (1988) combine Hofestede's framework in one composite index. Their cultural distance score, which can be calculated for any pair of countries, has been widely applied in international research (e.g., Erramilli and Rao 1993; Harzing 1999, 2002; Hennart and Larimo 1998; Kaufmann and Carter 2006; Luo 2001a) and particularly in the field of international R&D and cross-border knowledge transfer (e.g., Ambos and Schlegelmilch 2004; Ambos, Ambos, and Schlegelmilch 2006; Hakanson and Nobel 2001; Phene and Almeida 2008).

The literature often applies the terms cultural distance and psychic distance synonymously (e.g., Evans and Mavondo 2002; Gomes and Ramaswamy 1999; Kogut and Singh 1988; Lee 1998). Some scholars, however, argue for a broader interpretation of psychic distance. In addition to cultural aspects covered, they also include national environmental differences. Dow and Karunaratna (2006), for instance, consider differences in culture, language, religion, education, political systems, and time zones.

Despite advocating for a broader definition of psychic distance, Dow and Karunaratna admit that the majority of articles recently published in the Journal of International Business Studies (one of the leading journals in the field) that refer to cultural or psychic distance relied on Hofstede's cultural dimensions or Kogut and Singh's related measures. In addition, Tihanyi, Griffith, and Russell (2005) assert in their meta-analysis on different effects of cultural distance that most existing studies apply the same measure of cultural distance based on Kogut and Singh (1988). Moreover, for purposes of this study, focusing on cultural aspects in a narrower sense is also reasonable from a content perspective because aspects of the broader definitions are already directly or indirectly captured by other constructs.

Hence, this study applies Kogut and Singh's (1988) definition and measurement of cultural distances. The cultural distance score for each country was calculated based on the deviation between Germany and the respective host country for each of the dimensions. The index is calculated as:

$$CD_j = \sum_{I-1}^{4} \left[\left(I_{ij} - I_{iu} \right)^2 / V_i \right] / 4$$

where CD_j is the cultural differences of the j^{th} host country from the host country (Germany), I_{ij} represents the index of the i^{th} cultural dimension and the j^{th} country, and V_i represents the variance of the index of the i^{th} cultural dimension. The cultural distance score ranged from 1.23 (Brazil) to 3.77 (Malaysia).

6.2 Dimension B: Industry-Based Features

Dimension B of the research framework comprises exogenous environmental variables influencing the configuration of R&D in emerging economies. Three of the four variables introduced in the framework are multidimensional constructs consisting of multiple indicators. The other one is a single-item construct operationalized with only one indicator. Integrating single-item constructs in the context of SEM is in line with earlier literature (see, e.g., Birkinshaw, Morrison, and Hulland 1995). For an overview

please refer to Fassott and Eggert (2005). In the past, it was argued that constructs are better measured with multi-item measures than with single-item measures (see Churchill 1979). More recently, however, researchers note that constructs measured with one item can be as effective as constructs measured with a large number of items. Bergkvist and Rossiter (2007) showed that there is no difference in the predictive validity of the multiple-item and single-item measures for certain circumstances. They argue that constructs have been operationalized by multiple items when single-item measures could be used and call for more parsimonious measures. In the study at hand, cost pressure and local product adaptation are considered to be concrete. Therefore, the application of a single-item measure is appropriate (see Bergkvist and Rossiter 2007). In PLS, measurement models with one indicator are set equal to constructs with multiple indicators regardless of the type of measurement model (Henseler and Fassott 2010). As a consequence, the construct validation is not applicable for the two single-item constructs of the framework.

6.2.1 Technological Complexity

In existing studies, different scales have been used for measuring technological complexity. Kogut and Zander (1993) measure complexity of technology in terms of different types of manufacturing processes. Some authors apply “technology intensity” measured as the average ratio of R&D spending to sales (e.g., Cantwell and Mudambi 2005; Osborn and Baughn 1990). Several studies rely on aggregated R&D data at an industry or company level (e.g., Kobrin 1991; Kogut and Singh 1988). Gomes-Casseres (1989) also uses R&D industry average values gained but admits that “it would have been better to use the actual characteristics of the subsidiary” (p.8). In this study, the construct “technological complexity” intends to capture the technological characteristics of products handled by the subsidiary. It has been operationalized by three indicators: TecComp.1 measures the research intensity. With growing research intensity, products and processes are more innovative and more sophisticated; TecComp.2 covers the general technical complexity of products; and

TecComp.3 targets the technology advantage relative to the competitive environment.

Table 14 shows the results of the construct "technological complexity". Item TecComp.3 had to be deleted because of a negative weight sign. This result implies that complexity is driven by general product characteristics rather than by the firm's technology strategy. Both remaining items show high content validity. Multicollinearity does not pose an issue because correlation stays well below the critical threshold value. Indicator relevance is given for both indicators at the 0.1% (TecComp.1) and 5% (TecComp.2) level. With π of 0.59, research intensity seems to be the most important driver of technology complexity.

		Content validity		Multicollinearity		Indicator relevance			
Construct level		p_{sa}	c_{sv}	CI_{max}	VDP_{2nd}				
		1.00	1.00	n.a.	n.a.				
Item level		p_{sa}	C_{sv}	r_{max}	VIF	π	t	α	sign
TecComp.1	Products are research-intensive	1.00	1.00	-0.44	n.a.	0.59	4.05	***	✓
TecComp.2	Products are technically complex, no simple parts	1.00	1.00	-0.44	n.a.	0.31	1.69	*	✓
TecComp.3	We try to outperform our competitions by offering products with more advanced technology	eliminated							

Table 14: Fit Criteria of the Construct "Technological Complexity"

6.2.2 Technological Turbulence

Technological turbulence describes the degree of change associated with product and process technologies in the industry in which a firm is embedded (Glazer and Weiss 1993; Hanvanich, Sivakumar, and Hult 2006; Jaworski and Kohli 1993; Moorman and Miner 1997). A high degree of turbulence is associated with a high degree of change and unpredictability regarding the technical requirements. Because product specifications for new technologies might not be stable and standardized yet, firms might rely on feedback and input from lead customers to optimize and further

develop the products according to customer needs. Moreover, competitive pressure might force firms to constantly innovate and bring new technologies faster to the market, leading to higher rates of new product introductions (also referred to as industry clockspeed (Fine 1998)) and thus to more frequent changes in product and/or process technologies.

Accordingly, technological turbulence has been operationalized by four indicators: 1) instability of technical requirements over time; 2) necessity of customer input to technological requirements; 3) technological change forced by the industry; and 4) time-to-market improvements forced by the industry. All indicators were measured on a five-point Likert scale.

		Content validity		Multicollinearity		Indicator relevance			
Construct level		p_{sa}	c_{sv}	CI_{max}	VDP_{2nd}				
		1.00	1.00	10.94	0.34				
Item level		p_{sa}	C_{sv}	r_{max}	VIF	π	t	α	sign
TecTurb.1	Technical requirements are instable over time	1.00	1.00	-0.13	1.03	0.31	2.03	*	✓
TecTurb.2	Technical requirements require customer input	1.00	1.00	-0.25	1.08	0.05	0.46	(n.s.)	✓
TecTurb.3	Each year our industry forces significant technological changes	eliminated							
TecTurb.4	Each year our industry forces significant time-to-market improvements	1.00	1.00	-0.25	1.08	0.87	8.74	***	✓

Table 15: Fit Criteria of the Construct "Technological Turbulence"

The results of the construct are depicted in Table 15. Contrary to expectations, TecTurb.3 showed a negative weight sign and thus had to be eliminated. A possible explanation might be a narrow interpretation of "technological changes". Respondents might have limited technological change to radical innovations only (see Tellis, Prabhu, and Chandy 2009). The remaining three indicators show a high content validity. Multicollinearity does not represent an issue because the indicators exhibit only minor pair-wise correlation. The negative sign indicates substitutive effects between

the items, confirming the formative nature of the operationalization. In addition, CI_{max} and VDP_{2nd} are well below the threshold values. The evaluation of indicator relevance shows that TecTurb.1 and TecTurb.4 are statistically significant at the 5% and 0.1% levels, respectively. The insignificance of TecTurb.2 might lead to the conclusion that, in an emerging economy setting, customer specifications with regard to innovative technologies is rather low. Instead of customer specifications, technological innovation and change seems be mainly triggered by competition within the industry, forcing shorter product development cycles. This indication is underscored by the indicator weight of 0.87 for TecTurb.4.

6.2.3 Local Responsiveness

In this study, local responsiveness relates to the degree to which products need to be customized to local requirements. The present work thus considers the variable in the narrower sense of product modifications and adaptations to local requirements.

In the context of the integration-responsiveness paradigm, literature has built on "responsiveness" as one dimension to define MNEs' internationalization strategies (e.g., Bartlett and Ghoshal 1989; Johnson 1995; Leong and Tan 1993; Prahalad and Doz 1987). Regarding this dimension, different labels and conceptualizations have evolved over time. Unlike the present study, these operationalizations generally consider responsiveness in a broader sense (e.g., Taggart 1998c) and as synonymous with localization of activities (e.g., Harzing 2000). The study of Luo (2001b) models responsiveness as a focal construct and analyzes its major determinants. He operationalized the construct on the basis of three questions covering a subsidiary's responsiveness to strategic, structural, and overall environmental changes. This approach also underlies a broad perspective of the construct; moreover, it does not contain R&D-specific insights.

Considering local responsiveness in terms of local product adaptation, Kotabe and Omura (1989) applied a four-point scale to measure the level of product adaptation of

European and Japanese MNEs for the U.S. market. In the current study, local responsiveness has been conceptualized as an environmental variable that is analyzed for its effect on international R&D configuration. Focusing on the necessity of product adaptation for the local host market, it has been operationalized as a single-item construct on a five-point scale. Respondents were asked to assess the importance of adapting products to local requirements to successfully adapt to local business conditions. The Likert scale ranged from 1 (not at all important) to 5 (extremely important).

6.2.4 Cost Pressure

Companies are subject to different degrees of cost pressure. This corresponds to Bartlett and Ghoshal's (1989) typology, which considers cost pressure – in addition to pressure for local responsiveness – as one dimension to define internationalization strategies. The product life cycle perspective assumes that price competition varies across time and intensifies with increasing maturity and standardization. In later stages, there is a tendency toward low-cost strategies, an approach more in line with Porter's (1980) industry structure view (see Nadeau and Casselman 2008, p.404). Porter defines cost leadership as one of the three generic competitive strategies that firms can choose to compete in the market. In this study, "cost pressure" comprises both aspects: firm external industry pressure (Cost.1) and firm internal cost pressure derived from the competitive strategy of the firm (Cost.2). To measure Cost.2, the questionnaire asked for the "price" rather than for the "cost". This formulation was chosen because pricing strategy was considered to be more tangible for the respondents to evaluate the company's positioning relative to competitors. This approach is also in line with Porter (1980), who argues that cost leadership typically goes along with aggressive pricing.

Table 16 shows the results of the measurement model. Both items display high content validity. Problems of multicollinearity do not occur because pair-wise correlation r_{max} stays well below the threshold value. The negative correlation coefficient indi-

cates a substitutive effect between the two items. With stronger industry cost pressure, the firms seem to increasingly avoid price competition and instead choose alternative competitive strategies. The evaluation of indicator relevance shows that the weights of both indicators are significantly different from zero: Cost.1 at the 0.1% level, Cost.2 at the 5% level. The indicator weights reveal that industry cost pressure is of higher relevance (π=0.86).

		Content validity		Multicollinearity		Indicator relevance			
Construct level		p_{sa}	c_{sv}	CI_{max}	VDP_{2nd}				
		1.00	1.00	n.a.	n.a.				
Item level		p_{sa}	C_{sv}	r_{max}	VIF	π	t	α	sign
Cost.1	Each year our industry forces significant cost improvements	1.00	1.00	-0.23	n.a.	0.86	4.55	***	✓
Cost.2	We try to outperform our competitors by offering products with lower prices	1.00	1.00	-0.23	n.a.	0.32	1.71	*	✓

Table 16: Fit Criteria of the Construct "Cost Pressure"

Finally, Table 17 depicts the correlation matrix of the independent variables introduced. It shows that multicollinearity is not an issue because all correlations stay well below the threshold of +/-0.9.

		Mo	EI	Cult	TecComp	TecTurb	LocRes	Cost
Market opportunities	Mo	1.00						
Economies of location	EI	0.19	1.00					
Cultural distance	Cult	-0.02	-0.10	1.00				
Technological complexity	TecComp	0.00	-0.02	0.04	1.00			
Technological turbulence	TecTurb	0.06	0.10	-0.10	0.33	1.00		
Local responsiveness	LocRes	0.33	0.13	-0.02	0.04	0.14	1.00	
Cost pressure	Cost	0.04	0.23	-0.17	0.09	0.34	0.09	1.00

Table 17: Correlation Matrix of the Independent Variables

6.3 Dimension C: R&D Configuration

Dimension C of the research framework comprises the three international R&D configuration strategies constituting the endogenous variables of the framework.

There is a wide body of literature concerning the different subsidiary strategies and roles (e.g., Bartlett and Ghoshal 1986; Gupta and Govindarajan 1991; Jarillo and Martinez 1990; Taggart 1997; White and Poynter 1984). As outlined in the literature review, several approaches have been used to measure MNEs' international R&D configuration. Most of the existing typologies and roles are taxonomies measured at the MNE level or categorizations of foreign R&D activities based on several or a dichotomous set of factors or motives. Moreover, they often do not differentiate between the dimensions used to measure the strategy variables (endogenous action) and the motives that are expected to influence the choice of strategy (exogenous pressure), preventing an analysis of the effect of specific environmental features on R&D configuration. Therefore, previous operationalizations of international R&D strategies and roles were not appropriate for purposes of this study. To overcome the described issues, the basic scale emerging from Jarillo and Martinez (1990; 1991) was adapted for this study to measure the R&D configuration strategy. This scale allows for the calculation of the degree of localization and integration at the subsidiary level. To measure the degree of localization abroad, this study follows the definition of Kumar (2000a; 2000b) and understands localization as the share of value creation that is, from a subsidiary perspective, received neither from headquarters nor from other foreign affiliates. Following Kobrin (1991), integration is defined as intra-firm resource flow across borders. It is operationalized by analyzing the share of "imported" and "exported" R&D results of the individual subsidiaries. Conceptually, this procedure corresponds to the measurement of the knowledge inflow and outflow on the subsidiary level by Gupta and Govindarajan (1991; 1994).

Respondents were asked (1) whether their affiliate conducts R&D. If yes, they were asked to indicate (2) what share of their R&D results are used by foreign group mem-

bers (output interdependencies), and (3) what share of their affiliate's products builds upon R&D conducted by headquarters or other foreign subsidiaries (input interdependencies). The strategy mix for each subsidiary is calculated based on the share of received R&D, which is denoted as M, and the share of R&D provided for other group members, which is denoted as X.

The value of "Global Innovation" is measured by the share of exported value creation X:

$$GI = X$$

The value of Implementation (IMP) is calculated based on the share of R&D results received by the foreign affiliate for local market use:

$$IMP = (1-X) * M$$

The value of "Local Innovation" represents the share of local value creation for the local market. It covers all those R&D activities that a subsidiary conducts without any cross-border integration and can be calculated as follows:

$$LI = 1-(GI+IMP) = 1-X-(1-X) * M = (1-X) * (1-M)$$

Table 18 provides an overview of the calculations of R&D configuration strategies as they were applied for this study.

Based on this operationalization, the three strategies add up to one. The derived strategy is calculated from the free combination of the three types of configuration. Thus, instead of grouping subsidiaries into distinct categories (e.g., by using median splits along the measures (e.g., Ambos, Ambos, and Schlegelmilch 2006, p.301), a strategy mix can be derived for each subsidiary. This approach allows for the analysis of current configuration strategies and developments over time, as well as an analysis of substitutive effects between the different strategies.

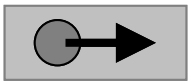
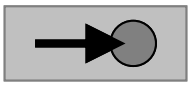
R&D configuration strategy		Variables	Question
Global Innovation (GI)		X	• Which share of R&D results are used by other group members ? → X
Implementation (IMP)		(1-X) * M	• Which share of your affiliate's products builds upon R&D conducted by other group members? → M
Local Innovation (LI)		(1-X) * (1-M)	
		∑ = 100%	

Table 18: Calculation of R&D Configuration Strategies

In addition to providing the current import and export shares, respondents were also asked about their current plans for the future. A time horizon of five years was chosen, which is in line with existing empirical research in the field of IB (e.g., Martinez and Jarillo 1991) and with Kaplan and Norton (2007), who recommend a five-year planning horizon for resource allocation. Inquiring about imports and exports for two points in time allows us to answer the exploratory research question for the intertemporal development of R&D configurations.

7 Empirical Results and Discussion

The goal of this thesis is to understand the features related to the configuration of foreign R&D activities in emerging economies. This chapter provides answers to the four research questions addressed by the thesis. The first section addresses research questions 1a and 1b and analyzes: a) the R&D configuration strategies of German firms in emerging countries, and b) how these strategies vary in different settings. The second section addresses research questions 2a and 2b and analyzes the influence of location-based and industry-based features on R&D configuration according to the hypotheses derived in Chapter 4.

7.1 Exploratory Results

Before carrying out an investigation of the drivers of R&D configuration, one may start with a sense of how R&D is actually configured (research question 1a) and move on to consider how the configurations differ in different host countries, in different industries, and with differences in affiliate and MNE characteristics, as well as how the strategies change over time (research question 1b). The corresponding analysis to answer these questions is done in an exploratory manner and corresponds to ”fact-finding research“, which tries to discover differences in data and to explain these differences (see Wacker 1998, p.372). It serves two main purposes: First, the analysis provides researchers with insights, food for thought, and impulses for further research in this field. Second, it provides managers with a richer understanding of industrial R&D activities in emerging countries.

7.1.1 Research Question 1a: Which R&D Configuration Strategies Do Foreign Subsidiaries in Emerging Countries Pursue?

Figure 7 depicts the average R&D configuration strategy mix held by the 268 analyzed subsidiaries in percentage points. The results clearly show that Implementation represents the most widespread strategy for German MNEs in emerging countries.

With shares of 18% and 10%, respectively, the Local Innovation and Global Innovation strategies are less prevalent.

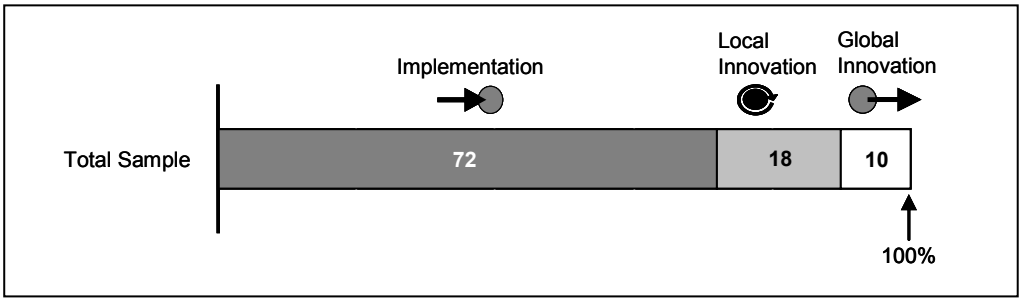


Figure 7: Average R&D Configuration Strategy Mix of Foreign Subsidiaries

This distribution of the three strategies supports the expectation that most R&D work is not localized in emerging economies; subsidiaries prefer to rely on the R&D competencies of other parts of the MNE network. Despite the observed trend of increasing investments in R&D in emerging economies in the past two decades (Boehe 2008; Gammeltoft 2006; UNCTAD 2005), major R&D activities and leading-edge innovation are still concentrated in competence centers in the triad and are rarely relocated in emerging economies; such centralization thus allows firms to benefit from economies of scale (Dalton and Serapio 1999; Kumar 2001). The bulk of subsidiary R&D in emerging countries comprises customization or minor adaptation of products or processes to local customer preferences or to local technology and factor markets. The available evidence supports that one-way technology transfer from headquarters to the foreign affiliate (Kaufmann and Roessing 2005) is still predominant; bidirectional and intense technology interaction across segments of a globally dispersed value chain, with lateral or reverse knowledge transfer, plays a minor role (10%). Instead, the output of local R&D in emerging countries is mainly targeted for local use within the subsidiary. Regarding output interdependencies, Ambos and Ambos (2009a, p.34) found evidence that the beneficiary from non-triad R&D units is usually headquarters; while the laboratories are closely linked to headquarters' operations, they

maintain far looser ties in horizontal relationships, such as to other foreign R&D units or manufacturing sites.

In addition to the average strategy mix of the subsidiaries, the consideration of "pure" strategies (see Habib and Victor 1991) allows further insights. A "pure" strategy is one in which the share of a certain strategy accounts for 100%. In the present sample, 60% of the investigated subsidiaries follow a "pure" Implementation strategy (i.e., they fully build on technologies that have been developed by other units without performing their own R&D activities). This level indicates that the majority of companies still refrain from establishing R&D units in emerging economies. Yet 40% of the subsidiaries in the sample have built up distinct R&D competencies and develop their own product and/or process technologies. Of these subsidiaries, 14% follow a pure Local Innovation strategy or Global Innovation strategy. In the former case (i.e., Local Innovation), the R&D units perform all innovation activities for the respective local subsidiary independently and without interdependencies with headquarters and other affiliates of the MNE network. This independence requires the laboratories to have a broad set of competencies covering knowledge of all relevant technology fields. In the latter case (i.e., Global Innovation), the R&D units are part of an international, interdependent innovation network and provide all their product or process technologies to other MNE group members for subsequent use. These laboratories are usually highly specialized and possess great expertise for certain products or technologies.

The results revealing that value creation of R&D units in emerging countries is mainly limited to minor support activities, such as facilitating the transfer and application of product and process technologies, confirm the findings of previous studies on R&D in "peripheral" countries. Ambos and Ambos (2009a) report in their exploratory study of foreign R&D investments that firms primarily localize their R&D activities in developed countries rather than in non-triad countries. Investigating the reasons, the authors found that the strong increase in R&D localization abroad that has been observed since the 1990s primarily results from a significant increase in capability-augmenting and knowledge-seeking R&D investments. The majority of such units are located in

innovation clusters or “pockets of knowledge“, which can, in turn, be primarily found within triad countries. This argument is also reflected in the operationalization of constructs (see Chapter 4.1.2), implying that spillovers from clusters are not considered an important source of competitive advantage in emerging countries. Based on their analysis, Ambos and Ambos (2009a) conclude with regard to the localization of R&D activities that “the prospects of non-triad nations to participate in the quest for inward R&D will be relatively low” (p.33). Manolopoulos, Papanastassiou, and Pearce (2007, p.678) studied the characteristics of R&D in Greece, as an example of a middle-income and peripheral country in terms of industrial development. The results of the study also reveal that adaptation of existing products and technologies to local conditions, which corresponds to the Implementation strategy in this study, still represents the primary aim of subsidiary R&D in a peripheral country context. In contrast, studies on international R&D in developed countries report far higher levels of R&D activities related to accessing new technological knowledge and capabilities. Kuemmerle (1997) observed that about 45% of foreign R&D sites are considered to be HBA units that are intended to generate benefits from the local technological expertise. Drawing on data from the European patent office, Le Bas and Sierra (2002) estimate the share of resource- or technology-seeking R&D investments abroad at about 47% for all MNEs and at approximately 55% for German MNEs. The study of Ambos (2005) finds this mandate in only about 33% of the foreign R&D units. Ambos explains part of the difference by turning to the different measurement criteria applied in the studies: While patent studies rely on output measures, his survey measures mandates in terms of input – namely, the percentage of personnel working on HBA as opposed to HBE projects. Thus, the results of the current study indicate that, compared to subsidiary R&D in developed countries, R&D in emerging countries is characterized by a lower degree of localization, with a predominance of support and adaptation activities and a lower degree of cross-border integration regarding the output of subsidiary R&D.

7.1.2 Research Question 1b: How Do These Strategies Vary Across Different Contexts and Over Time?

To get further and more detailed insights into the configuration of R&D in emerging countries, variations across different contexts and over time were investigated. This analysis goes beyond the scope of most extant studies and thus provides a further contribution in the understanding of MNE subsidiary R&D strategies. Split sample analyses were conducted for several grouping variables to identify differences for the following parameters: industry affiliation, host country affiliation, MNE characteristics, subsidiary characteristics, and temporal effects.

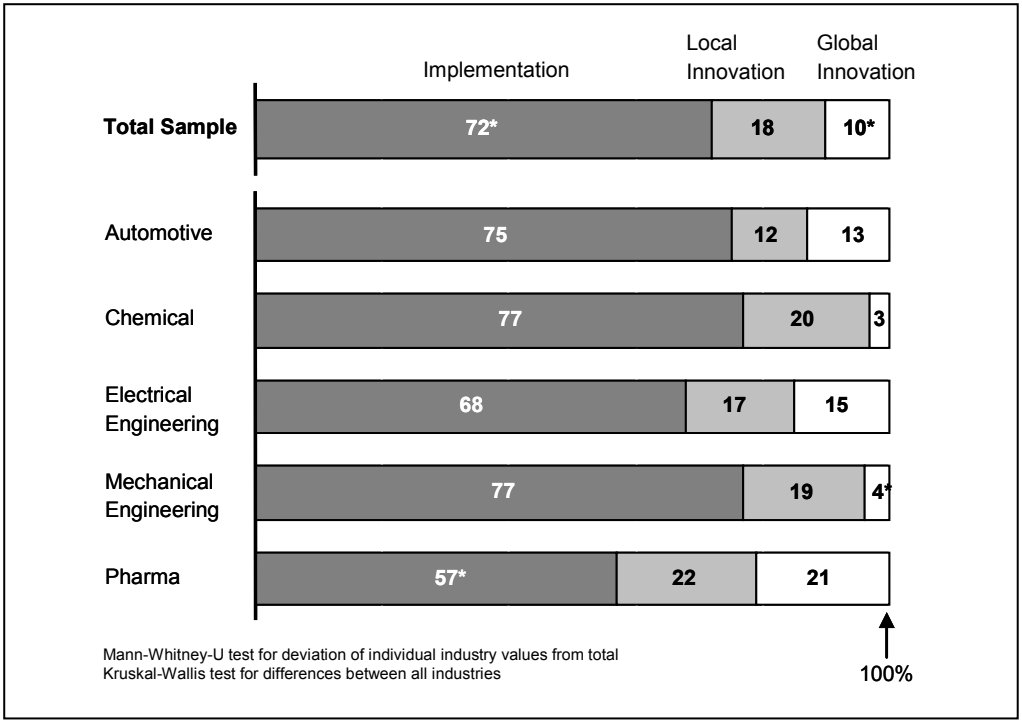


Figure 8: Average R&D Configuration Strategy Mix by Industry

Figure 8 depicts the average strategy mix by industry, showing differences between all industries and the deviation of individual industry values from the total sample. Significant differences between the five investigated industries can be observed for both the Implementation and the Global Innovation strategy; however, the differences do not reach a maximum level of statistical significance ($p<5\%$). The distribution of the R&D strategies among the industries shows significant differences in the pharmaceutical and mechanical engineering sectors. Note that while this analysis solely considers descriptive differences between subsidiary R&D strategies based on industry affiliation, research question 2b addresses the influence of specific pressures within the industry on the R&D configuration. These pressures might vary in the five industry categories because each of the categories comprises various sectors that might be charaterized by different features and structures.

Considering the distribution of the configuration strategies between the industries, it turns out that the Implementation strategy accounts for nearly the same share in all industries except pharmaceuticals. With a share of 57% ($p<5\%$), the subsidiaries in the pharmaceutical industry rely to a significantly smaller degree on Implementation, suggesting that pharmaceutical companies perform more R&D locally in emerging economies compared to the other manufacturing industries. Accordingly, this approach is also reflected in its highest share of Local Innovation and Global Innovation, revealing both a perceived need for the development of local products and a high degree of subsidiary-level innovativeness in the industry. The R&D activities of these pharmaceutical subsidiaries are, more than in the other industries, integrated into the global company network and are providing inputs that other units subsequently use; this arrangement allows the foreign R&D units to contribute to the creativity and competitiveness of the overall group.

This pattern of R&D internationalization supports previous findings. Manolopoulos, Papanastassiou, and Pearce (2007) found that foreign subsidiaries in the pharmaceutical industry in Greece have the lowest commitment to a support laboratory role compared to other industries, indicating that local R&D “was not merely related to

meeting local testing and regulatory requirements" (p.667) but instead undertook more substantial innovation activities. In an earlier study, Gerybadze and Reger (1999) already observed that pharmaceutical firms are significantly different from those in other industries because they have a higher proportion of foreign R&D. Also, Niosi (1999) concluded that firms in the pharmaceutical industry are at the "forefront of the globalization of R&D" (p.108). This pioneering role not only seems to hold for the internationalization of R&D in developed countries, as investigated by previous studies, but, as the current study indicates, also seems to hold for the more recent localization of R&D activities in emerging economies.

Mechanical engineering and the chemical sector exhibit the lowest degree of local value creation and output interdependencies with other units, with significant deviations for the mechanical engineering industry ($p<5\%$). Some subsidiary R&D is performed to develop local products; however, most of the technology comes from other parts of the organizational network, and only a marginal part of the R&D activities is provided to other units. The low degree of Global Innovation in mechanical engineering might result from a centralization of innovation activities in the home country. Gerybadze and Reger (1999) assert that MNEs from large European countries with a predominant technology base in their home country (e.g., mechanical engineering and automotive) "still tend to concentrate a significant part of their research in the country of origin" (p.259). Germany, in particular, is known for its centers of excellence in the mechanical engineering sector (Kaufmann and Tritt 2007), with industry clusters providing a fruitful environment for innovation and the development of competitive advantages (Grünert and Fuchs 2007). Regarding the chemical sector, previous studies show mixed results. Manolopoulos, Papanastassiou, and Pearce (2007) do not explicitely differentiate between the pharmaceutical and chemical industries and likewise report a comparatively high degree of global innovation for both sectors. Also, the patent analysis of Le Bas and Sierra (2002) revealed that, for foreign R&D in European countries, HBA FDI in R&D, which in principle corresponds to the Global Innovation strategy, represents the dominant strategy in the technological fields related to the pharmaceutical and chemical industries. However, the results of the cur-

rent study indicate that there are differences between these two industries. This finding is supported by the investigation of Ambos and Ambos (2009a) on R&D in peripheral countries; their study found evidence that, in particular, laboratories in the chemical industry possess only local market responsibility. Although the data of this study do not show a significant difference in relation to the total sample, the relatively high degree of Local Innovation and low degree of Global Innovation in the chemical industry provide a hint in this direction. The authors offer the following statement from a manager in a chemical company to reflect the exception in the industry: “The reason for setting up an R&D unit in the host country is due to the fact they cannot get the same ingredients in the host country as in the home country and thus have to do some research and fine-tuning and adjust their product using the resources available in the home country” (see p. 33; “Germany” replaced by ”home country” and “India” replaced by “host country”).

Figure 9 depicts the average R&D configuration strategy mix by host country. Note that, in contrast to the industry split, variations between the five analyzed countries reach a high level of significance for all strategies. Furthermore, variations of individual host countries from the total sample turn out to be more pronounced than for individual industries.

India and Brazil are the countries that attract the most local R&D activities. With 45% and 41%, respectively, subsidiaries located in these countries undertake a significantly higher degree of innovation activities than the average of the subsidiaries in all countries (28%). Both countries also exhibit the highest degree of Local Innovation and Global Innovation. The extensive performance of local-for-local activities (28% in India and 25% in Brazil) can be explained by the large market size of both countries, which motivates firms to develop locally the products that fit the specific host market requirements. High host market volumes and growth rates reduce the hurdles to investment in R&D because a sufficiently large local market allows subsidiaries to spread R&D costs over a higher output volume. India and Brazil not only attract market-seeking R&D investments but also, compared to other emerging countries, are

attractive offshore locations for resource-seeking R&D. The relatively high proportion of R&D activities that are performed for subsequent use by other members of the MNE network (17% in India, 16% in China) indicates that both countries offer abundant resources required for innovation activities at relatively lower costs, prompting MNEs to locate part of their R&D activities in these locations. This finding is consistent with the results, provided by Ambos and Ambos (2009a), that identify India and Brazil as preferred locations for globally integrated R&D activities; these researchers observed that "[o]nly a very few of our sampled firms located their capability augmenting activities in one of the rare knowledge clusters outside the triad. India and Brazil, both large markets, are the most popular locations" (p.33).

Interestingly, China exhibits a lower degree of local R&D activities compared to the other two market heavyweights, India and Brazil, and instead relies on technologies from other countries. There might be several reasons for this finding. While many MNEs consider India to be the "world's development center", with attractive conditions for R&D activities, China has gained the reputation as the "world's elongated workbench", providing attractive conditions for the localization of manufacturing activities (Kaufmann, Koch, and Panhans 2006). This difference might also be caused by the relative scarcity of qualified personnel and the difficulties in attracting, retaining, and motivating engineers and scientists that are able to perform sophisticated development tasks (Kaufmann et al. 2006b). Furthermore, investment barriers, such as insufficient protection of intellectual property rights and enforcement of contracts, constrain the localization of R&D activities in China (Kaufmann et al. 2006a; Weeks 2000; Yang and Jiang 2007). MNEs fear a loss of their know-how to local competitors and corresponding economic damage because of plagiarism and counterfeit products (Kaufmann and Jentzsch 2006; Luo and Park 2001). Also, the interviews conducted by Zedtwitz (2004) on R&D in China revealed that intellectual property issues are of concern particularly for nonpublic-domain innovation activities, leading to a lower degree of local value creation. The author asserts that "[i]t is important to notice that some of the surveyed R&D centers were not conducting indigenous technology R&D but rather [were] focused on technology monitoring and corporate R&D representa-

tion. While these R&D units would not qualify as full-fledged R&D labs by most interpretations, they are nevertheless part of the parent company's international R&D network and often form the nucleus of more significant future R&D investment" (p.443). However, extant research found mixed evidence of the role of intellectual property protection on the localization of R&D activities. Kumar (2001), for instance, could show that the lack of adequate patent protection does not affect the attractiveness for R&D in emerging countries in cases where the country is otherwise well-suited for R&D activity.

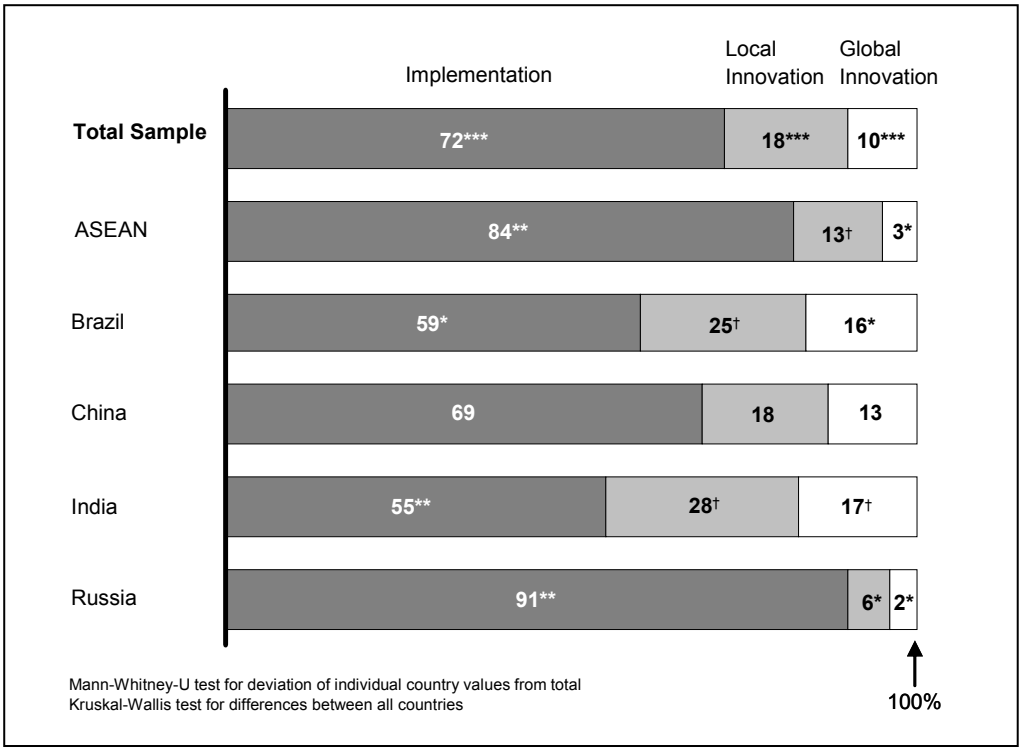


Figure 9: Average R&D Configuration Strategy Mix by Host Country

Russia stands out for its high share of Implementation, which is significantly more

pronounced (91%, p<1%) than in any other of the investigated countries, at the cost of Local Innovation and Global Innovation. The corresponding low degree of local value creation might be ascribed to market opportunities that have been found to represent the most important motive for activities of German companies in Russia, while location advantages only play a subordinate role. Companies largely rely on products that have been developed at corporate headquarters or other R&D labs for sales in Russia. Moreover, the country exhibits high investment barriers, particularly regarding regulations and transparency of the business environment (Kaufmann, Panhans, and Tritt 2007), presenting unfavorable conditions in particular for headquarters' commitment to localize knowledge-intensive activities, such as R&D, that are considered a source of competitive advantage (Delios and Henisz 2000; Roessing 2006).

Subsidiaries in ASEAN countries also exhibit a relatively low share of local R&D activities and rely on R&D competencies of other units from the MNE network (84%, p<1%) at a higher-than-average level. The output of the local R&D units is mainly targeted for use in their respective local subsidiary; development activities for third markets play hardly any role. This configuration can be attributed to the small size of the individual economies and market differences within the region (Kaufmann and Tritt 2007), rendering the development of individual products for each market commercially unattractive. Furthermore, in the past there have been major obstacles and delays in the integration process toward an effective domestic market (Stadtmann, Kaufmann, and Weigand 2004). MNEs investing in ASEAN still face some trade barriers in the region, impeding effective cross-border integration and the exploitation of economies of scale.

The R&D strategy mix also was analyzed for its sensitivity with regard to MNE and subsidiary characteristics. The grouping variables were dichotomized for split-sample analysis (high and low level) along the median. This procedure corresponds with common research practice (e.g., Goerzen and Beamish 2003). While the previous analyses assessed the deviation of individual group values from the total value, as well as the differences between all groups, the following context variables directly ad-

dress the two respective subsamples derived from the median split.

Figure 10 illustrates the effect of MNE-related characteristics on subsidiary R&D strategy in percentage points and the corresponding cut-off values. Turnover and the number of employees have been used to capture the size of the MNE and therefore have similar effects, although with differing strengths. It can be inferred that larger MNEs make stronger use of Global Innovation in emerging economies at the cost of the Implementation and Local Innovation strategies. Despite the negative sign for Local Innovation, one can observe a net increase in local value creation. Thus, larger firms tend to have a higher proportion of R&D activities located in emerging economies. Furthermore, these units are more closely integrated into the MNE network and develop new products for global or other emerging markets, allowing the MNEs to benefit from advantageous host country factor markets on the one hand and economies of scale on the other. Thus, larger firms tend to make better use of offshore, knowledge-intensive value creation while smaller firms tend to avoid investments to build up and maintain R&D competencies in emerging economies.

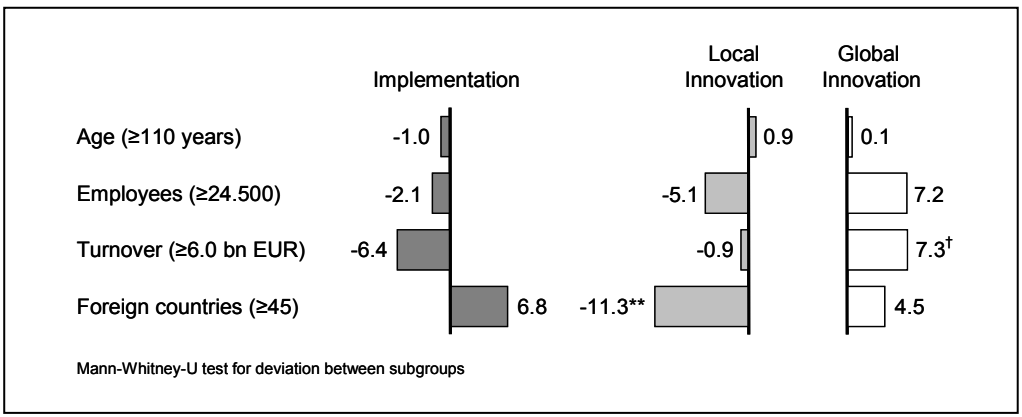


Figure 10: MNE-Related Differences in Average R&D Configuration

International experience, measured as the number of countries in which the MNE operates, is significantly negatively related to Local Innovation (-11.3%, p<1%), implying

that MNEs that are active in a larger number of countries more strongly rely on an integrated network of internationally dispersed R&D units. Rather than replicating R&D activities in each country to develop products for the local market, the companies bundle innovation activities in centers that have cross-border responsibilities. Enright (2009) expected international experience of a firm to be positively related to the localization of R&D activities but found no significant relationship. He attributes the lack of significance to the fact that R&D represents a threshold activity that may not depend directly on international experience beyond a certain level, inducing MNEs to have only limited numbers of R&D locations (see p.833). The present analysis supports this proposition.

Figure 11 depicts group differences for subsidiary characteristics. The results indicate that subsidiary-related characteristics seem to be more strongly related to R&D configuration than MNE-related characteristics. In contrast to the age of the MNE, which showed no significant effect on R&D configuration, the subsidiary age was found to be connected with increases in Local Innovation and Global Innovation at the cost of Implementation. This reveals that subsidiaries that have been established for a longer period tend to localize more R&D activities – mainly to develop specific products for the local market (+14.5%, $p<0.1\%$) but also to provide technological capabilities for other parts of the network (+4.1%, $p<1\%$). This increasing localization is consistent with the learning theory of internationalization, which assumes that firms internationalize with a stepwise increase in foreign value creation and resource commitment after they have gained sufficient experience in the local country. The growing importance of Global Innovation could be explained by the local R&D unit's increasing competence and performance over time. This argumentation is in line with prior research finding the performance of a laboratory site to be positively related to the age of the site (Kuemmerle 1998) and suggesting that, with increasing maturity, a subsidiary can contribute more creatively to technology generation within the MNE network, "having had time to evolve away from principally a domestic orientation and towards more closely internationally integrated relationships" (Cantwell and Mudambi 2005, p.1124).

Subsidiary size in terms of employees and turnover is also positively related to the localization of R&D activities, which is reflected in significantly increasing shares of the Local Innovation and Global Innovation strategies at the cost of Implementation. That larger subsidiaries would perform more innovation activities seems logical. Kuemmerle (1998) argues that if R&D sites are too small, there is not enough opportunity for a stimulating exchange among R&D groups and a lack of access to scientific support structures within the subsidiary, which negatively affects the performance of the unit. Accordingly, larger subsidiaries are in a superior position to develop distinct technological competencies that allow the R&D unit to contribute to the MNE's global innovation network. Nevertheless, the greater increase in local-for-local innovation, compared to output generation for other units, suggests that local market drivers prevail over supply drivers for subsidiary growth in emerging economies.

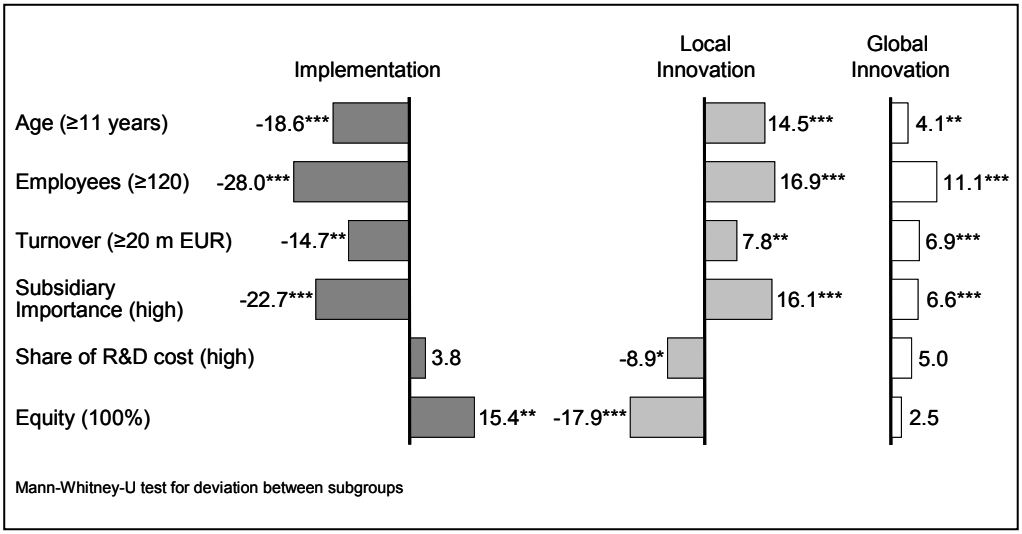


Figure 11: Subsidiary-Related Differences in Average R&D Configuration

Subsidiary importance was measured based on the number of employees, using a ratio of subsidiary employees to MNE employees. The larger this ratio, the higher the relevance of the subsidiary within the group. Consistent with the absolute measure of

subsidiary size, it turns out that relatively important subsidiaries are less dependent on technological input from the rest of the MNE and instead revert to their own R&D competencies to develop products for the local subsidiary (+ 16.1%, $p<0.1\%$), as well as for other units of the MNE network (+ 6.6%, $p<0.1\%$).

The share of R&D costs was measured on the basis of the product cost composition of the end products, as indicated by the survey respondents. The median share of R&D costs of the investigated firms is 6%, which corresponds approximately to the average share of internal R&D expenses on gross value added for German manufacturing industries (Stifterverband 2010). The analysis shows that a high share of R&D costs is negatively related to Local Innovation (-8.9%, $p<5\%$), in favor of Implementation and Global Innovation. This relationship implies that research intensity encourages firms to link R&D activities across borders in a limited number of laboratories, enabling a better use of available competencies and the realization of specialization and scale effects, as well as enabling MNEs to avoid costs of duplicate development work in independent R&D units (Gassmann and Zedtwitz 1998, 1999; Reger 2004). Although the deviations do not reach statistical significance ($p>0.1\%$), it is interesting to observe that there is a larger increase of Global Innovation (+5.0) than of Implementation (+3.8); this indicates that MNEs facing a high share of R&D costs tend to maintain interdependent R&D units in emerging economies, which allows them to take advantage of favorable labor costs compared to units in developed countries (Li and Yue 2005; Zedtwitz 2004).

The variable “equity share” was analyzed for differences between wholly owned subsidiaries and joint ventures. Wholly owned affiliates exhibit a significantly higher degree of Implementation (+15.4%, $p<1\%$) at the cost of Local Innovation (-17.9%, $p<0.1\%$). A positive effect is also visible on Global Innovation (+2.5%), although without reaching statistical significance. In other words, the results suggest that joint ventures act independently and are less integrated into the global MNE innovation network, in terms of technological input and output. A broad body of literature has investigated the circumstances under which MNEs choose to establish foreign joint ven-

tures with local partners rather than wholly owned subsidiaries (e.g., Brouthers, Brouthers, and Werner 2001; Gomes-Casseres 1989; Hennart 1991; Madhok 1997; Mutinelli and Piscitello 1998; Penner-Hahn 1998; Zheng, Anand, and Mitchell 2005). These studies have generally confirmed that a lack of local market knowledge motivates parent firms to collaborate with a local partner that provides complementary resources and is familiar with the idiosyncratic ways of doing business. Knowledge on the specific local market requirements might induce subsidiaries to build up R&D capabilities, allowing them to turn specific market insights or technological capabilities into products that fit with the specific local customer preferences. Wholly owned subsidiaries are more likely if the parent firm plans to transfer advanced proprietary technologies to its foreign operations. Full ownership is preferred because of the risk of opportunism and the potential expropriation and misuse of the MNE's technical product and process know-how by the (local) joint venture partner (Isobe, Makino, and Montgomery 2000; Tackaberry 1998). These hazards are more salient in emerging countries, relative to developed countries, because they typically lack effective institutional legal frameworks, such as the protection of property rights (Spicer, McDermott, and Kogut 2000; Zhang et al. 2007; Zhao 2006). In some cases, local government might even provide tacit support for local firms to expropriate proprietary technologies of the MNEs (Delios and Henisz 2000). Accordingly, MNEs are more reluctant to provide technological know-how to local joint venture firms compared to wholly owned subsidiaries, which is reflected in a higher degree of Implementation. Moreover, the literature on international R&D management has shown that the adaptation of coordination and control processes to efficiently manage an internationally dispersed network of R&D units is extremely difficult and requires substantial investments in new organizational routines (see Belderbos 2003, p.238). Thus, cross-border integration might be easier and less costly using an internal mode of control, causing firms to try to minimize interdependencies with joint ventures; this approach is then reflected in a higher degree of Global Innovation in wholly owned subsidiaries.

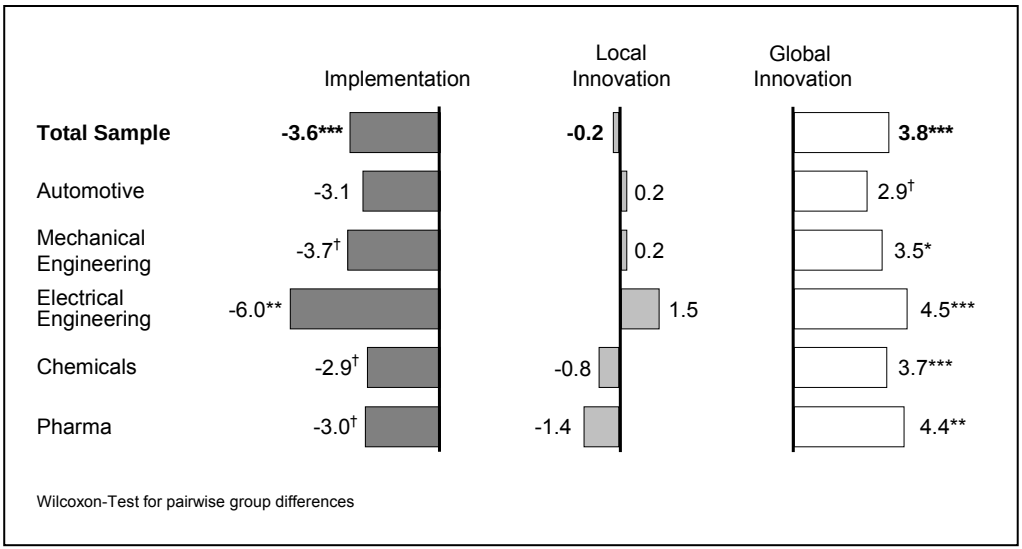


Figure 12: Expected Changes in R&D Configuration by Industry

The configuration of international R&D is not static but subject to development over time (Hegde and Hicks 2008; Le Bas and Sierra 2002; Patel and Vega 1999). To identify changes in configuration, we compare the current strategy mix with the mid-term plans by the subsidiary. In line with previous research by Jarillo and Martinez (1990, 1991), respondents were asked to provide information on the current resource interdependencies of their subsidiary and also on their firm's plans for the next five years, which typically represent the outcomes of the strategic planning processes.

Figure 12 depicts the planned changes in R&D strategy mix by industry. In total and over all industries, there is a significant increase in the share of Global Innovation (+3.8, $p<0.1\%$) at the cost of Implementation (-3.6, $p<0.1\%$), and Local Innovation shows only few changes that do not reach statistical significance. These results imply a general trend away from transferring technology from headquarters or R&D units in developed countries to subsidiaries in emerging economies and toward a more substantive localization of R&D activities in emerging economies. Emerging economy

subsidiaries thus will benefit from increasing international dispersion of R&D capabilities, and innovation processes will become increasingly globally polycentric (Sachwald 2008). In addition to their traditional adaptation and support activities, R&D units in emerging countries will gain more regional or global responsibility and develop toward centers of excellence (Forsgren, Johanson, and Sharma 2000; Frost, Birkinshaw, and Ensign 2002). They will be increasingly integrated into company innovation networks and will provide R&D competencies for other members of the MNE network. This development might also involve subsidiary specialization on the design and rollout of particular products or technologies (Archibugi and Pianta 1992; Cantwell 1992; Frost 2001).

The strongest intentions to increase the share of Global Innovation can be observed in subsidiaries of the electrical engineering industry (+4.5%, p<0.1%) and the pharmaceutical industry (+4.4, p<1%); the automotive industry exhibits the weakest dynamism (+2.9, p<10%). Interestingly, the electrical engineering and pharmaceutical industries already exhibit the highest absolute share of R&D localization (see Figure 8 and the related discussion). Thus, instead of seeing other industries catching up, these two industries will further strengthen their pioneering position regarding R&D capabilities in emerging economies. Despite their similar augmentation of Global Innovation, the two industries seem to follow somewhat different approaches: Subsidiaries in the electrical engineering sector intend to reduce the input provided by other units by 6% (p<1%), which represents the sharpest decline of all industries in favor of both Global Innovation and Local Innovation. The latter suggests an increasing effort to respond to specific local customer requirements. Subsidiaries in the pharmaceutical sector, in contrast, plan to reduce the technological input from headquarters and other units by 3% (p<10%); meanwhile, they also plan to reduce the amount of local R&D efforts targeted only toward the host country, allowing firms to realize additional economies of scale.

The increase of Global Innovation applies consistently across all analyzed industries and equally across all analyzed host countries (see Figure 13). India (+6.8%, p<0.1%)

and China (+6.4, p<1%) exhibit the highest expected increase in Global Innovation. Also, subsidiaries in Brazil and in the analyzed ASEAN countries are expected to develop more for other countries than they do today, although with considerably less dynamism (2.8%, p=0.05 and 1.9%, P<1%, respectively). Thus, subsidiaries in India remain the units with the highest share of local value creation and the highest output interdependencies with other members of the MNE network, underlining India's leading role as location of choice for offshore R&D (Neumann et al. 2006). The relatively small adjustments in the R&D configuration in Brazil might indicate a certain level of maturity there, with an appropriate strategy mix that fits environmental conditions. In contrast to all the other analyzed countries, subsidiaries in Russia were found to have no significant changes in their configuration strategies. Compared to other emerging economies, the country seems to offer less favorable conditions for the localization of R&D activities.

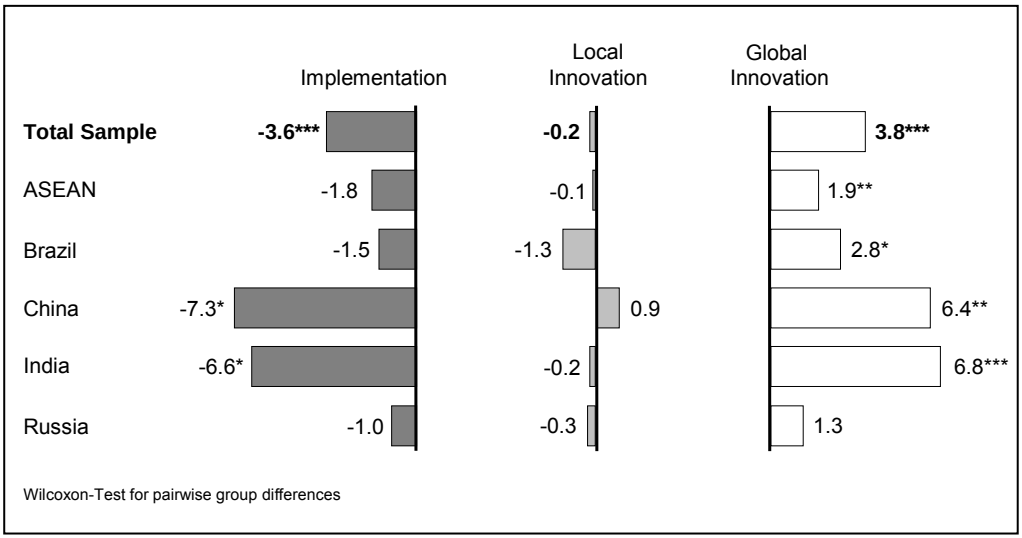


Figure 13: Expected Changes in R&D Configuration by Host Country

The pattern toward an increased integration of decentralized R&D units is in line with extant literature that has pointed to the emergence of global networks for innovation within MNEs in recent years (e.g., Cantwell 2009; Harzing and Noorderhaven 2006). Scholars have identified two major factors forcing MNEs to foster a more closely integrated and international innovation network: cross-border learning and consolidation. Based on case study research, Gassmann and Zedtwitz (1999) investigated trends in international R&D organizations and found that "[a]ll in all, we notice a trend toward the integrated R&D network. Pressure of cost reduction forces companies with an integrated R&D network to focus on a small number of leading research centers (re-centralization). The goal of this consolidation is to better exploit scale effects and to improve the coordination of worldwide dispersed R&D activities, simultaneously reducing the amount of duplicate R&D and intensifying cross-border technology transfer" (p.246). Similarly, Gerybadze and Reger (1999) arrive at the conclusion that MNEs are increasingly able to create and operate multiple centers of learning at different geographical locations and to manage cross-border learning from different sites. This finding is consistent with the evolutionary view of the firm that emphasizes the importance of the MNE's capability to learn from each transfer abroad and to accumulate knowledge on how to apply tacit knowledge across borders in different geographical locations (Belderbos 2003; Kogut and Zander 1993, 1995; Penner-Hahn 1998). Stressing the need for consolidation, Zedtwitz, Gassmann, and Boutellier (2004) found that the orchestration of globally dispersed R&D units poses several challenges related to integrating local R&D units into coherent global networks. They conclude that, after a decade of "jungle growth in R&D internationalization when companies vigorously pursued opportunistic development" (p.27), MNEs face the challenge of efficiently configuring their innovation activities to fully exploit the potential of globally dispersed R&D activities. Similarly, Reger (2004) found that the quantitative growth of international R&D units has to be accompanied by a qualitative dimension, which he sees in the restructuring of global R&D toward specialized R&D units with MNE-wide responsibility. Looking at foreign R&D in Greece, Manolopoulos, Papanastassiou, and Pearce (2007) found "clear signs of integration/interdependence of work in R&D labs with other parts of MNE networks" (p.661).

To conclude, it can be observed that literature suggests a general trend toward internationally interdependent innovation networks. The empiricism of the current study reveals that this direction also holds for subsidiaries of German MNEs in emerging economies and applies consistently across different industries and host countries. Subsidiaries in emerging economies are expected to benefit from further internationalization of innovation activities through the upgrading and extension of local R&D. What remains, despite this development, is that the adaptation of existing product and process technologies retains the strongest position in emerging economies, but with decreasing relevance; meanwhile, an increased movement toward Global Innovation presages an increased claim by subsidiaries to a position in their MNE's innovation program and drives creative synergies in emerging economies on an international scale.

7.2 Confirmatory Results

This section addresses research questions 2a and 2b and empirically verifies the hypotheses developed in Chapter 4. The first subsection investigates the influence of location-based features on subsidiary R&D configuration (hypotheses H1-H3). The second subsection analyzes the influence of industry-based features on subsidiary R&D configuration (hypotheses H4-H7). The third subsection provides an overview and discussion of the entire framework. The presentation and discussion of results in these three sections is expected to add to the clarity and interpretation of the research findings.

To avoid an excessive number of hypotheses and to ensure an adequate consideration of substitutive effects between the strategies, the excepted relationships of each of the seven exogenous variables on the three R&D strategies have been combined into one hypothesis for each exogenous variable. The individual relationships are thus considered as sub-hypotheses a, b, and c. Accordingly, the following discussion explicitly considers the relationships between the exogenous variables and each indi-

vidual R&D strategy and focuses on the direction, significance, and strength of the structural relationships.

7.2.1 Research Question 2a: How Do Location Factors Relate to the Choice of International R&D Configuration in Emerging Countries?

Hypothesis 1 assumes a positive relationship between market opportunities and both the Implementation and Local Innovation strategies and a negative relationship between market opportunities and Global Innovation. The empirical results reported in Table 19 support the expected positive effect on Implementation and the negative effect on Global Innovation at the 1% and 0.1% level, respectively. The path coefficients toward Local Innovation show a reverse sign, although without reaching statistical significance.

	Exogenous variable	Endogenous variable	Expected relationship	γ	α	Sign
H1	Market opportunities	Implementation	+	0.23	**	✓
		Local Innovation	+	0.05		✓
		Global Innovation	–	-0.30	***	✗

Table 19: Empirical Results for Market Opportunities and R&D Configuration Strategies

The strongest effect occurs between market opportunities and Global Innovation (γ=-0.30, $p<0.1\%$). Consistent with the predictions, Global Innovation stands in contrast to the importance of local market opportunities because of its focus on third markets, confirming a strong substitution effect between host market importance and output-related interdependencies within the MNE network.

The identified positive relationship with the Implementation strategy (γ=0.23, p<1%) supports previous findings according to which a considerable share of market-seeking R&D activities abroad is dedicated to the adaptation and customization of existing technologies to local requirements (Ambos and Ambos 2009a; Kumar 2001; Manolopoulos, Papanastassiou, and Pearce 2007). Contrary to expectations, market opportunities do not favor local-for-local innovations and thus do not increase the localization of R&D activities. Instead of developing distinct products locally for the respective host market, subsidiaries in emerging economies prefer to adapt product and process technologies that have been developed by headquarters or other units to local conditions. The aim to exploit local market potential thus does not induce the subsidiary to perform its own innovation activities on a larger scale. A possible reason for this finding might be the high costs related to the localization of independent R&D activities in the host country. Rising R&D costs cause MNEs to integrate dispersed innovation activities to avoid internationally independent R&D activities that might lead to duplicated developments (Zedtwitz, Gassmann, and Boutellier 2004). In addition, declining costs of intra-company technology transfer, which might come from technological developments in information and communication technologies or from superior knowledge management systems, foster cross-border integration of innovation activities. Another possible explanation might be the convergence of customer preferences, reducing the value of market proximity and thus local R&D (Kumar 2001). Homogenous demand across countries allows subsidiaries to build on existing technologies and to confine their activities to minor adaptations that require fewer resources rather than to the development of new, location-specific products from scratch. Finally, some emerging economies might not provide the necessary resource conditions considered necessary for the localization of high-quality R&D activities. For example, lack of qualified local engineers or absence of supporting infrastructures and local scientific cooperation partners might prevent firms from localizing major R&D activities in certain emerging countries, despite a high relevance of market-seeking motives (Narula and Dunning 2000).

The insignificant effect of market opportunities on Local Innovation is also in line with

Sanna-Randaccio and Veugelers (2007), who found a positive relationship between a subsidiary's ability to use central R&D resources and subsidiary profitability, leading the authors to conclude that "market size loses importance as a factor shaping the geographical pattern of R&D internationalization" (p.59). The identified positive relationship with the Implementation strategy also supports previous findings according to which a considerable share of R&D activities in peripheral countries is dedicated to the adaptation and customization of existing technologies to local requirements (Ambos and Ambos 2009a; Manolopoulos, Papanastassiou, and Pearce 2007).

Table 20 depicts the empirical results for the interrelation between economies of location and R&D configuration. Economies of location are presumed to exert a positive influence on Local Innovation and Global Innovation at the cost of Implementation. Moreover, the positive effect on Global Innovation is expected to be stronger than the effect on Local Innovation. It turns out that all three path coefficients show the expected signs and are statistically significant at the 0.1% level for Implementation and Global Innovation and at the 5% level for Local Innovation.

	Exogenous variable	Endogenous variable	Expected relationship	γ	α	Sign
H2	Economies of location	Implementation	–	-0.26	***	✓
		Local Innovation	+	0.12	*	✓
		Global Innovation	+	0.26	***	✓

Table 20: Empirical Results for Economies of Location and R&D Configuration Strategies

Consistent with expectations, economies of location exhibit a positive relationship with the localization of R&D activities in the host country, which is reflected in the

positive path coefficient on both Local Innovation and Global Innovation. Moreover, the expectation that the positive effect on Global Innovation would be stronger than the positive effect on Local Innovation was justified by the perceived opportunity to exploit factor advantages of the host country across borders. The analysis reveals a stronger path weight for the relationship between economies of location and Global Innovation (γ=0.26) compared to Local Innovation (γ=0.12) and thus supports the expected relationship. Interdependencies with other units allow the firm to exploit location advantages of the host country for the benefit of the whole MNE network. Location advantages can be related either to factor cost or to factor quality, which are both covered in the second-order construct economies of location (see Chapter 4.1.2). In both cases, attractive host country conditions favor the localization of R&D activities and their integration into the firm's global innovation network. Foreign R&D units in emerging economies thus not only play a role as cost-efficient, offshore service providers in the MNE network but also are expected to contribute to knowledge acquisition, learning, and competence development of the group by accessing and dispersing the geographically bound technological knowledge of the host country.

The significant positive relationship between economies of location and the Local Innovation strategy shows that advantageous factor conditions in the host country also encourages subsidiaries to perform R&D activities for local use, although the factor conditions do not provide a competitive advantage over local competitors. However, the combination of technological know-how that is "imported" from other parts of the MNE network and advantageous local factor conditions, either in terms of cost or quality, might allow the subsidiary to gain a competitive edge over local competitors. Furthermore, local R&D activities might substitute for R&D activities for the local host market that would otherwise have been performed in high-cost countries and thus might compensate for comparative cost disadvantages vis-à-vis local competitors.

As expected, the Implementation strategy is negatively affected by the existence of economies of location (γ=-0.26) at a highly significant level. This finding supports the anticipation that minor adaptation or customization activities are not suitable if sub-

sidiaries are to benefit from location advantages. Major innovation activities and thus the majority of value creation in R&D are conducted by other group members, which prevents the exploitation of economies of location in the subsidiary's host country. This result clearly indicates that favorable factor markets attract the localization of R&D activities in emerging countries. The finding that supply-side factors are decisive for locating R&D in emerging economies represents a contribution to the understanding of the phenomenon under investigation because extant literature shows mixed results in this regard. Manolopoulos, Papanastassiou, and Pearce (2007) concluded that supply-side factors are not seen as decisive in drawing MNE R&D into Greece, taken to be representative of a "peripheral" country with mid-level industrial development. In contrast, based on qualitative expert interviews on foreign R&D in China, Zedtwitz (2004) proposes that, in addition to market proximity, technology competence drives MNEs to localize R&D activities in China. The results of the present study support the proposition that advantageous factor conditions foster the localization of R&D activities in foreign subsidiaries in emerging countries. The difference between this finding and that of Manolopoulos, Papanastassiou, and Pearce (2007) might be explained by the different host countries under investigation. Their study investigated subsidiaries in a "peripheral" country that is located in relatively close proximity to technologically leading Western European countries. In addition to the relative geographical proximity, the investigated peripheral country (i.e., Greece) might not be considered as superior a location in terms of the quality and/or costs of R&D personnel in direct comparison with the nearby advanced countries. Thus, relative host country location advantages might not represent a major motive for foreign MNEs to locate R&D activities there. The current study, meanwhile, does not consider "peripheral" countries but instead investigates subsidiaries in the leading emerging economies in the world. These countries might have larger differences in their factor endowments in terms of cost or availability of trained personnel, compared to the MNEs' home country, allowing firms to translate advantageous factor conditions into international competitive advantages.

As indicated, economies of location cover both quality-related and cost-related as-

pects. Although the literature is pretty consistent regarding factor quality, there are mixed results regarding the effect of factor costs as motive for R&D localization abroad. On the one hand, some government surveys indicate that costs of R&D personnel are ranked among the least important motives for foreign R&D, even in the case of emerging countries (European Commission 2006; Thursby and Thursby 2006). On the other hand, recent studies argue that cost-related aspects are gaining importance as motive for the (re-)location of R&D (Edler 2008; Sachwald 2008). The results of the present study support the latter findings, with factor costs being part of economies of location and being positively related to the localization of R&D activities in emerging economies. This finding is consistent with Kumar (2001), who argues that, as long as qualified R&D personnel are available, factor costs represent an important motive for the localization of internationally interdependent R&D activities abroad.

	Exogenous variable	Endogenous variable	Expected relationship	γ	α	Sign
H3	Cultural distance	Implementation	+	0.13	*	✓
		Local Innovation	–	-0.08	†	✓
		Global Innovation	–	-0.12	*	✓

Table 21: Empirical Results for Cultural Distance and R&D Configuration Strategies

The empirical results for the interrelation between cultural distance and R&D configuration are depicted in Table 21. Hypothesis 3 assumes a negative relationship between cultural distance and both the Local Innovation strategy and the Global Innovation strategy. A positive substitution effect is anticipated for the Implementation strategies. All three relationships exhibit the expected signs and are statistically significant, providing unanimous support for hypothesis 3. This result confirms the litera-

ture arguing that, despite all advancements in modern communication and information processing technologies, cultural differences are still challenges that influence the configuration of a firm's international value chain (Luo 2001b; Nachum and Zaheer 2005).

The negative effects on Global Innovation (γ=-0.12, p<5%) and Local Innovation (-0.08, p<10%) reveal that a lack of commonality between the cultural frameworks of the home and host countries hampers the localization of R&D activities in the foreign subsidiary and hence can be considered an investment hurdle in emerging economies. The stronger negative effect on Global Innovation compared to Local Innovation can be explained by the difficulties of cross-border integration arising from different cultural backgrounds between the locations. The transfer of knowledge and capabilities created at the foreign subsidiary for further use and processing within the MNE network is more difficult and costly and is subject to higher risk when cultural distance is high. For asset-seeking R&D investments, these factors reduce the value of reverse technology transfer from the host country R&D unit to headquarters, which typically represents the most important recipient of R&D output from units in emerging economies (Ambos and Ambos 2009a). For cost-efficiency–seeking R&D investments, cultural distance diminishes the potential cost advantages derived from internal, offshore R&D service providers in low-cost countries.

The positive effect on the Implementation strategy (γ=0.13, p<5%) supports the expectation that high cultural dissimilarities motivate firms to limit their resource commitment in the host country and to choose a configuration with a low degree of local value creation abroad. Firms thus prefer to maintain major R&D activities in locations with low cultural barriers. Host countries with a cultural framework similar to that of the home country are considered more favorable for the localization of R&D abroad than locations with a more divergent cultural setting.

Table 22 provides a summary of the hypothesized relationships and results (sign and significance level) obtained in relation to research question 2a. The expected sign of

the relationships between location-based features and subsidiary R&D configuration refers to the overview of the hypothesis presented in Table Table 3 at the end of Chapter 4.2.1. Of the nine investigated causal relationships between location features and R&D configuration strategies, eight were found to be statistically significant and exhibited the expected sign (indicated by '✓'). Only the path coefficient between market opportunities and Local Innovation had a reverse sign (indicated by '×'), yet without reaching statistical significance (indicated by '()'). Thus, the obtained results support eight of nine hypotheses, namely H1a and H1c, as well as H2a-c and H3a-c. These results can be considered highly satisfactory.

			Endogenous variable: IMP (a)		LI (b)		GI (c)	
	Exogenous variable							
H1	Location-based features	Market opportunities	+	✓**	+	(×)	–	✓***
H2		Economies of location	–	✓***	+	✓*	++	✓***
H3		Cultural distance	+	✓*	–	✓†	–	✓*

Table 22: Comparison of Model Results and Hypotheses for Research Question 2a

7.2.2 Research Question 2b: How Do Industry Factors Relate to the Choice of International R&D Configuration in Emerging Countries?

This subsection addresses research question 2b and discusses the empirical results on the causal relationships between industry-related features and subsidiary R&D configuration in emerging economies.

Hypothesis 3 assumes that technological complexity shows a positive effect on the Implementation and Global Innovation strategies and a negative effect on the Local Innovation strategy. The empirical results depicted in Table 23 show that two of the three relationships exhibit the expected signs and are statistically significant.

	Exogenous variable	Endogenous variable	Expected relationship	γ	α	Sign
H4	Technological complexity	Implementation	+	-0.02		✗
		Local Innovation	–	-0.13	*	✓
		Global Innovation	+	0.18	***	✓

Table 23: Empirical Results for Technological Complexity and R&D Configuration Strategies

In line with expectations, product complexity negatively affects Local Innovation (γ=-0.13, p<5%). This result confirms that stand-alone R&D units without international ties to other parts of the MNE network are not considered adequate in dealing with sophisticated, complex technologies. Because of the focus on the host country only, Local Innovation requires firms to invest in similar and redundant R&D activities in different countries. Developing technologically complex products requires a high level of R&D capabilities and high resource commitment. A decentralized configuration without interdependencies between the units does not allow for the leveraging of resources across borders and prevents specialization and scale efficiencies.

Consistent with expectations, the relationship between technological complexity and the Global Innovation strategy was positive. The strong effect (γ=0.18, p<0.1%) clearly supports that technological complexity favors specialization and cross-border integration of foreign R&D activities. This result also indicates that there is no contra-

diction between technological complexity and the localization of R&D activities in emerging countries. In other words, sophistication does not represent an investment hurdle in emerging economies. On the contrary: Firms aim to leverage the technological know-how of their foreign subsidiaries for the benefit of the global MNE network. Thus, in sophisticated industrial environments dealing with complex technologies, technology sourcing seems in fact to be a motive for the localization and integration of R&D activities, not only in developed but also in emerging economies.

Interestingly, the analysis reveals that the positive effect on cross-border integration holds only for output but not for input interdependencies. Contrary to expectations, there is no positive effect on Implementation, although this strategy, similar to Global Innovation, is also characterized by interdependencies with other units of the MNE network. The analysis exhibits a negative sign for the relationship between technological complexity and Implementation, yet only with a very small and insignificant weight (-0.02, p>10%). This result is unexpected and, at first sight, also counterintuitive for two reasons: First, the common argument, already described, is that specialization and integration foster centralization of R&D. Second, and even more surprising, is that one might expect complex technological activities to be predominantly performed in R&D units in developed countries rather than in emerging economies. Both arguments would imply a positive relationship with Implementation because this strategy builds on R&D output from innovative units in developed countries. However, the results do not support a centralization effect of technological complexity in favor of developed countries; they thus support recent evidence that high-value innovation activities become increasingly geographically dispersed in the international network of an MNE (Cantwell 2009; Ernst 2002; Rugman and Verbeke 2009).

Kumar's (2001) study might present a tentative explanation for the findings. His analysis revealed different industry patterns among U.S. MNEs vs. Japanese MNEs. While U.S. firms follow what he calls a "normal sectoral pattern of innovation in that affiliates in more R&D-intensive industries also do more R&D abroad" (p.171), Japanese MNEs in relatively technology-intensive sectors retain their R&D activities at

home and move abroad only in relatively simpler technology sectors. From the results of the present study, it can be inferred that foreign subsidiaries of German MNEs facing higher degrees of technological complexity do not localize fewer R&D activities in the host country. In this regard, German firms would instead follow a pattern similar to U.S. MNEs, as opposed to Japanese MNEs. Yet this finding presents only a first hint and calls for further research and a more detailed examination of the relationship between technological complexity and localization of R&D in emerging economies. In this context, further investigations might also analyze whether "traditional" theoretical approaches, assuming emerging economies to be less suitable for performing technologically complex R&D, still reflect today's realities (see, e.g., Chng and Pangarkar 2000).

Hypothesis 5 anticipates a positive relationship between technological turbulence and both the Local Innovation strategy and the Global Innovation strategy; a negative relationship is predicted for the Implementation strategy. The empirical results are depicted in Table 24. It turns out that technological turbulence exhibits the expected direction of effect on all three R&D configuration strategies, with all path coefficients being significantly different from zero at the 0.1% and 5% levels, thus leading to a unanimous support for hypothesis 5.

	Exogenous variable	Endogenous variable	Expected relationship	γ	α	Sign
H5	Technological turbulence	Implementation	–	-0.24	***	✓
		Local Innovation	+	0.12	*	✓
		Global Innovation	+	0.23	***	✓

Table 24: Empirical Results for Technological Turbulence and R&D Configuration Strategies

The Implementation strategy, which is characterized by a low degree of local value creation, ultimately is not considered adequate to deal with fast technological changes and reduced innovation cycles (γ=-0.24, p<0.1%). Instead, foreign subsidiaries facing these challenges prefer to maintain their own R&D capabilities. While Local Innovation emphasizes international independence and speed-to-market activities by endowing the subsidiary with flexibility to react quickly to technological changes, Global Innovation emphasizes international interdependencies with listening post activities by providing proximity and access to local knowledge sources for use within the MNE network. Consistent with expectations, the positive effect on Global Innovation turns out to be stronger (γ=0.23, p<0.1%) than the effect on Local Innovation (γ=0.12, p<5%), indicating that in a turbulent environment, an effective innovation network with interdependent R&D units for technological monitoring and sourcing abroad seems to be of even greater importance than individual subsidiary flexibility. In addition, the monitoring of technological trends appears not to be limited to triad countries but also motivates firms to localize R&D activities in emerging economies. Thus, they have an ear on the respective local market and can respond to the latest technological developments as fast as possible, allowing them to gain a competitive edge over other firms in the market.

Taken together, the results lead to two major conclusions: First, technological dynamism within the industry fosters decentralization of firms' R&D and the localization of innovation activities abroad. Put differently, local R&D competencies help foreign subsidiaries respond to the "need for speed" in new product development. Second, the results indicate that firms facing high industry innovation pressure count on the contribution of R&D units in emerging economies. This finding is in line with recent empirical work contradicting the proposition that state-of-the-art technologies are proprietary to developed countries. Körte (2007), for instance, reports a positive relationship both between technological turbulence and competition in developed countries from emerging country competitors and between technological turbulence and activities of Western MNEs in emerging countries. Against the background of the identified relevance of technology turbulence as a determinant of subsidiary R&D configuration

and the lack of extant research on this relationship, the results of this study can be considered first insights that call for further, more detailed investigations, particularly with respect to theory development.

Hypothesis 6 assumes a positive relationship between local responsiveness and the Local Innovation strategy and a negative relationship for the Implementation and Global Innovation strategies. The empirical results depicted in Table 25 reveal that all path coefficients exhibit the expected sign, and two of them are statistically significant at the 1% level.

	Exogenous variable	Endogenous variable	Expected relationship	γ	α	Sign
H6	Local responsiveness	Implementation	–	-0.14	**	✓
		Local Innovation	+	0.19	**	✓
		Global Innovation	–	-0.02		✓

Table 25: Empirical Results for Local Responsiveness and R&D Configuration Strategies

In line with expectations, Local Innovation is positively affected by local responsiveness (γ=0.19, $p<1\%$). It can be inferred that firms count on geographical proximity between R&D and customers to tailor products to the specific market requirements. Proximity allows direct interaction with customers and their involvement in the product development process, and it thus facilitates the identification of specific needs and requirements. The immediate closeness to customers is a unique feature of the Local Innovation strategy.

Meanwhile, the other two strategies turn out to be negatively affected by local responsiveness. Both the Implementation strategy and the Global Innovation strategy

favor standardization over customization; the central development and cross-border bundling of R&D activities and in one location offers its full potential only when homogenous products are developed for several countries. Implementation exhibits a significant negative relationship with local responsiveness (γ=0.19, p<1%). Global Innovation shows the expected negative sign but fails to reach statistical significance. This insignificant interrelation might be explained by the fact that, in contrast to Implementation but in common with Local Innovation, Global Innovation requires local R&D competencies at the host country subsidiary. As mentioned, the need for location-specific products encourages local subsidiary R&D both to ensure customer proximity and to avoid communicating over long distances, which could be necessary when all R&D is centralized in the home country. The present study investigates subsidiaries in the major emerging markets of the world. MNEs might use their R&D activities in these locations not only to cover the respective host market but also to serve customers in neighboring countries that do not have their own R&D units or even have no local subsidiary. In other words, the R&D units in the major emerging markets might extend their geographical responsibility and, holding a kind of regional mandate for the customization of products, can ensure a certain proximity to customers also in the surrounding countries. This effect of "relative customer proximity" ("relative" in their relationship to a centralized R&D unit, for example in the home country) might potentially explain why there is no significant negative relationship between local responsiveness and the Global Innovation strategy.

Cost pressure is assumed to motivate firms to localize R&D activities in emerging countries. Hypothesis 7 expects a positive relationship between cost pressure and the Local Innovation and Global Innovation strategies and a negative effect on the Implementation strategy. The empirical results are depicted in Table 26. It turns out that the path coefficient toward Local Innovation reaches statistical significance with the expected sign and thus finds empirical support. The path coefficient toward Implementation exhibits the expected negative relationship but does not reach statistical significance. The effect of cost pressure on Global Innovation fails to reach statistical significance and shows a reverse sign.

	Exogenous variable	Endogenous variable	Expected relationship	γ	α	Sign
H7	Cost pressure	Implementation	–	-0.07		✓
		Local Innovation	+	0.14	*	✓
		Global Innovation	+	-0.04		✗

Table 26: Empirical Results for Cost Pressure and R&D Configuration Strategies

Consistent with expectations, there is a positive relationship between cost pressure and the Local Innovation strategy (γ=0.14, p<5%). With this configuration, foreign subsidiaries have broad innovation competencies and perform R&D for the host country locally, which entails two major advantages: First, the subsidiaries are able to benefit from local factor cost advantages compared to locations in high-cost countries, and second, they are able to act independently without facing costs related to cross-border coordination and communication. The latter aspect might also help to explain why, contrary to the expectation formulated in the hypothesis, subsidiaries do not choose Global Innovation as a means to adapt to competitive cost pressure (γ=-0.04, p>10%). Global Innovation allows firms to leverage factor cost advantages within the MNE network that are offered by low-cost locations, to exploit economies of scale, and to reduce the amount of duplicate R&D work across foreign subsidiaries. However, the analysis indicates that cost pressure does not motivate firms to pursue such a factor arbitrage and volume bundling across borders. As mentioned, costs related to the transfer of knowledge and the coordination of offshore R&D activities represent one potential explanation for this unexpected finding. Another potential explanation can be derived from the life cycle perspective. The IPLC theory assumes that cost pressure and relocation of value creation toward low-cost countries both gain importance with increasing product maturity. Over an industry cycle, growing competitive pressure increases the need for innovation efficiency, which requires a tight or-

ganizational setup and a minimum of slack resources (Strebel 1987). Regarding R&D, increasing maturity thus implies that functional activities are mainly focused on process-oriented and incremental innovations to optimize established technologies rather than on product-oriented and fundamental innovations (Lee and Stone 1994). Against this background, cost pressure might motivate firms to locate R&D activities in proximity to the manufacturing sites in low-cost countries to allow for a close collaboration between the two functions and thus to achieve maximum process efficiency.

The relationship between cost pressure and Implementation turns out to be, as expected, negative, although not statistically significant (γ=-0.07, p>10%). The lack of a significant result might be explained by a trade-off that characterizes this strategy: On the one hand, Implementation prevents firms from benefiting from factor cost advantages offered by low-cost countries. On the other hand, the strategy allows firms to realize efficiency gains through cross-border integration and avoidance of duplicate R&D work in several host countries. Firms facing high cost pressure have to balance these two effects carefully, which might lead to different outcomes depending on the evaluation of the different factors. Another possible explanation can again be derived from the life cycle perspective. Although manufacturing activities might be relocated in an emerging economy and attain factor cost advantages, the co-located R&D unit might not work completely independently from other units but still build on the technological competencies of other parts of the MNE network. Regarding the transition from product to process innovations related to industry maturation, Strebel (1987) argues that "[t]he improvements in the process technology do not create a discontinuous break with previous experience, but rather build incrementally on what went before" (p.118). This might lead to a certain task-sharing in R&D: While the host country unit primarily focuses on technological process optimization for manufacturing, the central R&D in the home country or another R&D competence center within the MNE network takes charge of the more fundamental innovations or the development of disruptive technologies as new sources of competitive advantage (Christensen 1997, 2001).

Altogether it can be inferred from the analysis that the mixed results of hypothesis 7

do not allow cost pressure to be considered a major motive for the internationalization of R&D activities in emerging economies. The previous discussion provides some possible ways to explain and reveals that additional research is required to investigate more deeply the influence of cost pressure on R&D in emerging economies. The results at hand suggest that in this context in particular, the interplay between subsidiary R&D, manufacturing, and central R&D in the home country represents a promising field for further insights and scientific progress.

			Endogenous variable: IMP (a)		LI (b)		GI (c)	
	Exogenous variable							
H4	Industry-based features	Technological complexity	+	(×)	–	✓*	+	✓***
H5		Technological turbulence	–	✓***	+	✓*	++	✓***
H6		Local responsiveness	–	✓**	+	✓**	–	(✓)
H7		Cost pressure	–	(✓)	+	✓*	+	(×)

Table 27: Comparison of Model Results and Hypotheses for Research Question 2b

Table 27 provides a summary of the hypothesized relationships and the results obtained in relation to research question 2b. Of the 12 investigated causal relationships, 8 were found to be statistically significant and exhibiting the expected sign. Two path coefficients exhibit the expected signs but are not statistically significant. The remaining two relationships – between technological complexity and Implementation, and between cost pressure and Global Innovation – turned out to have a reverse sign, and neither coefficient reached statistical significance. Thus, the obtained results

support the following hypotheses: H4b and c, H5a-c, H6a and b, and H7b. This result can be considered highly satisfactory, not least against the background of the scarcity of extant empirical insights.

7.2.3 Résumé of Structural Model Results

The effects of location-based and industry-based features on subsidiary R&D configuration in emerging economies have been evaluated within an integrated model according to the research framework outlined in Chapter 4.1. Summarizing the previously discussed relationships of the individual exogenous constructs with R&D configuration, Figure 10 depicts an overview of the overall structural model, including path coefficients, significance levels, and the coefficient of determination R^2 for each of the three dependent variables that constitute subsidiary R&D configuration.

Regarding the motives, it can be inferred from the significance and magnitude of the path coefficients that economies of location, technological turbulence, and market opportunities have a comparatively strong effect on the configuration of subsidiary R&D activities. This finding is all the more remarkable in that it provides evidence that favorable factor conditions, rather than attractive market conditions, represent a decisive motive for the localization of R&D in emerging economies. Market opportunities turn out not to foster the localization of R&D activities in these countries; instead of developing distinct products locally for the respective host market, subsidiaries in emerging economies prefer to adapt to the local conditions the product and process technologies that have been developed by other parts of the MNE network. Compared to the independent development of distinct products, such adaptations and modifications require far fewer innovation resources and capabilities in the host country. The results of the research model thus imply that the aim to exploit the market potential of emerging countries does not motivate foreign subsidiaries to conduct substantial R&D in the host country, while the possibility of benefiting from attractive location factors positively affects the localization of R&D abroad.

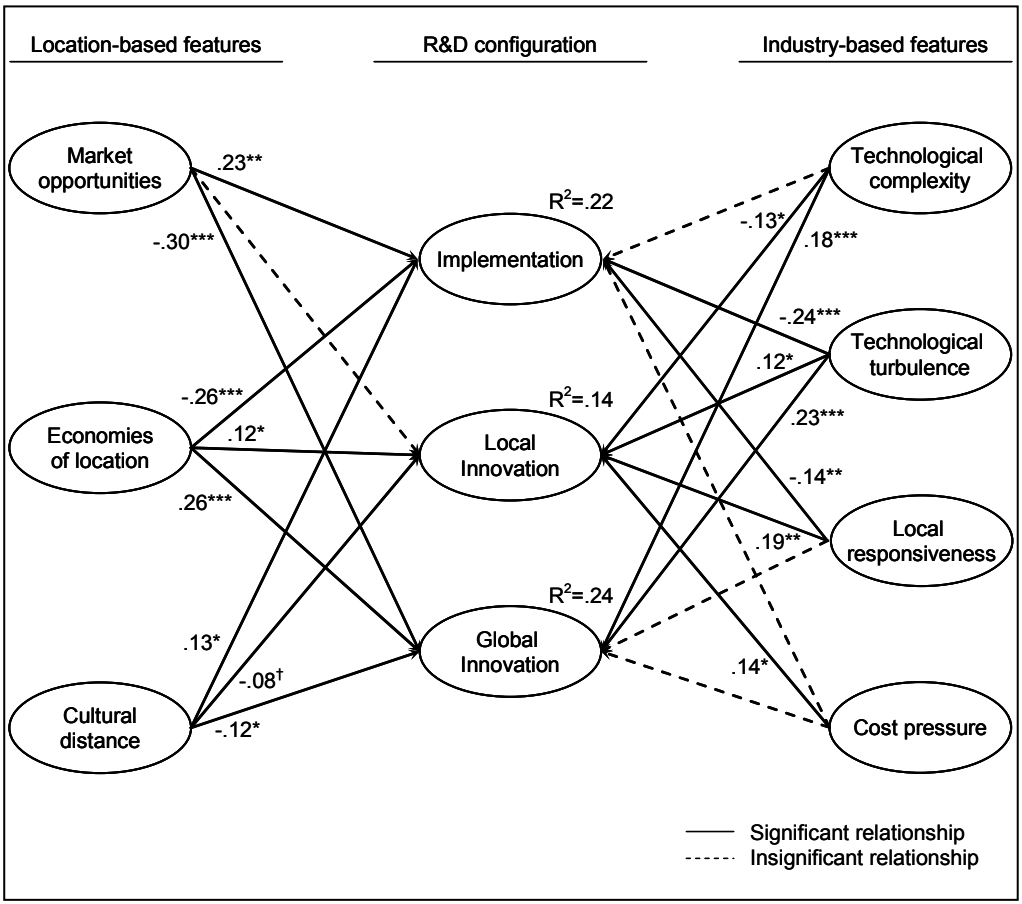


Figure 14: Overview of the Structural Model

Furthermore, technological turbulence turns out to be an important determinant of R&D configuration, with significant and comparatively high path coefficients toward all three R&D strategies. The positive effect on subsidiary innovation might be interpreted as an indicator that, even in emerging markets, time and speed to identify and react to the latest technological trends and developments represent important factors to compete and to sustain competitiveness in the global business environment (Stalk

Jr 1988). In contrast, cost pressure, which might have been expected to drive localization, exhibits a relatively low influence on subsidiary R&D configuration, with only one significant path coefficient. Particularly in the context of emerging economies, this lack of significance represents a rather unexpected result, indicating that the relocation of knowledge-intensive innovation activities does not primarily represent a direct answer to cost pressure. Cultural distance turns out to be a deterring factor for the localization of R&D activities abroad, with significant paths toward all three strategies. This finding indicates that, despite modern communication and knowledge-sharing technologies, hurdles and costs related to the transfer and exchange of knowledge with culturally distant countries still exist and are relevant; yet the comparatively low path coefficients suggest that cultural differences have lost some significance and are now of subordinate importance compared to the other location-based factors investigated here.

Regarding the R&D strategies, Implementation appears to be predominantly motivated by market opportunities while being discouraged mainly by technological turbulence and economies of location resulting from substitutive effects. Local Innovation is particularly driven by the need for local responsiveness, while technological complexity represents the most important factor of deterrence for this strategy. Finally, Global Innovation turns out to be mainly encouraged by economies of location and technological turbulence while being discouraged mainly by substitutive effects arising from local market opportunities in the host country. The strong effect of economies of location allows the conclusion that by following the Global Innovation strategy, MNEs seek to leverage foreign immobile resources and assets within the global innovation network, which makes subsidiaries in emerging countries a contributor to the innovative capabilities of the MNE.

8 Summary and Implications

The primary motivation of the present thesis was to advance the understanding of MNE subsidiary R&D by providing insights into the nature and motives of subsidiary R&D configuration in emerging countries. The work extends the existing empirical literature in that it systematically analyzed influencing factors on subsidiary R&D configuration strategies in an integrated framework and thereby provided a bridge between prior research on international R&D and foundational theories on internationalization. Innovation is considered a key source of competitive advantage, yet R&D has traditionally been one of the most centralized activities in the value chain. As global competition has intensified, global supply and specialization of science and technology resources have increased, and innovation has become more costly and risky. The R&D function has experienced rapid internationalization in the past few decades. New products and processes are no longer only developed in the home country and transferred to foreign subsidiaries to adapt them to local needs. Instead, foreign subsidiary R&D is regarded as playing a more substantial role in an integrated innovation network by taking advantage of specific resources and capabilities through relationships with the local environment and thus contributing to firms' innovation capacity. Moreover, internationalization of R&D is spreading. Although most R&D investments still go to industrialized countries, emerging countries have recently gained considerable importance and have attracted an increasing amount of R&D investments in recent years.

Our comprehensive review of the extant literature revealed that empirical work has primarily concentrated on foreign R&D in the industrialized triad countries. The nature and motives of R&D in emerging countries remains fairly uncharted territory. Moreover, the research field is very fragmented, with only scarce empirical research having been conducted on R&D at the level of the individual subsidiary within the MNE network. Extant studies investigating R&D at the subsidiary level lack a comprehensive analysis of the motivational factors driving the configuration of subsidiary R&D. Furthermore, literature on the internationalization of R&D appears as a rather independent research field, with only limited connections to other IB-related fields and

foundational theories. This thesis addresses the identified research gap by providing an empirical analysis of subsidiaries' R&D configuration in emerging countries and of motives determining the choice of the configuration. Relying on subsidiary level data, the present work builds on the idea of the MNE as a network of specialized, interdependent units and contributes to the increasingly influential literature on subsidiary strategy.

A typology for international R&D strategies was developed that bridges the gap between research on the internationalization of R&D and general IB research and that allows a comprehensive but parsimonious mapping of subsidiary R&D configurations. The strategies are structured along measurable and action-oriented dimensions (localization and integration of value creation activities) and allow for the analysis of gradual differences and gradual changes in the configuration. To provide a comprehensive perspective of the motives of R&D configuration and to cope with the effects of location- and industry-related features discussed in extant literature, the research followed a pluralistic theory approach building on strands of trade, FDI, and IB theory as well as on previous conceptual and empirical literature on R&D internationalization. Overall, a set of 7 hypotheses comprising 21 relationships was developed and empirically analyzed using a variance-based SEM approach on a sample of 268 foreign subsidiaries. The survey on which this thesis is based contains responses from subsidiary managers of German MNEs in five manufacturing industries in the major emerging markets of Brazil, Russia, India, China, and Southeast Asia (ASEAN).

The thesis explores two research questions: one linked to an exploratory analysis of subsidiaries' R&D strategies and a second of a confirmatory nature and linked to the hypotheses on the effects of location-based and industry-based environmental factors on R&D configuration. The central findings, implications, and suggestions for further research derived from this study are summarized in the following sections.

8.1 Central Results and Academic Contribution

Research question 1: a) Which R&D configuration strategies do foreign subsidiaries in emerging countries pursue?
b) How do these strategies vary across different contexts and over time?

Extant literature attested a lack of empirical insights into the nature of foreign R&D in emerging economies. To advance our understanding in this field, the present study provided a thorough investigation of the configuration of subsidiary R&D. Previous research has applied a variety of dimensions and taxonomies to characterize foreign R&D activities, however, a widely accepted standard has not yet been developed. Prior studies mostly relied on typologies that group R&D activities into distinct categories that inhibit the identification of both gradual variations between foreign R&D units and incremental developments over time. In addition, some categorizations are not disjunctive, which prevents a mutually exclusive mapping of foreign R&D activities; some apply heuristics to identify the type of strategy; and some are limited to a dichotomous set of roles. In fact, most extant typologies do not differentiate between the dimensions used to measure the strategy variables (endogenous action) and the motives that are expected to influence the choice of strategy (exogenous pressure), preventing an analysis of the effect of specific environmental features on R&D configuration. This study therefore developed a novel typology of subsidiary R&D configuration that conceptually refers to the influential contribution of Jarillo and Martinez (1990). The combination of the localization and integration dimension leads to a distinction between three archetypal subsidiary R&D strategies: Implementation, Local Innovation, and Global Innovation. A free combination of the three strategies allows the coexistence of different strategies in the same subsidiary and leads to a distinct R&D configuration for each subsidiary. This conceptualization leads to direct substitutive effects between the three R&D strategies, which was accounted for in the development of the hypotheses for the causal relationships that were addressed in research question 2.

The results of the present study reveal that subsidiaries of German manufacturing MNEs in emerging countries attach unequal levels of importance to the different R&D configuration strategies. On average across all surveyed subsidiaries, the Implementation strategy accounts for the largest share with 72%, followed by Local Innovation with 18% and Global Innovation with 10%. The distribution of the three strategies discloses a relatively low degree of local R&D value creation in emerging countries. Instead, subsidiaries prefer to rely on the R&D competencies of other parts of the MNE network. Hence, major innovation activities are still concentrated in competence centers in the triad countries. The bulk of subsidiary R&D in emerging countries comprises customization or adaptation of products or processes to local needs and conditions. The findings support that technology transfer toward emerging market subsidiaries is still predominant. As indicated by the relatively low share of Global Innovation, vertical or reverse transfer of knowledge out of emerging countries to other parts of the MNE network still plays a minor role; local R&D activities are mainly targeted for use within the host country subsidiary.

To provide further insights on context- and time-related patterns of subsidiary R&D configuration in emerging countries, variations across different contexts and over time were investigated (research question 1b). Regarding host country patterns, the present empirical study revealed that subsidiaries in India and Brazil possess the highest degree of local R&D activities of the investigated countries, registering exceptionally high shares of both Local Innovation and Global Innovation, at the cost of Implementation. This finding reflects the large market size of both countries and the availability of abundant resources required for innovation activities. Interestingly, subsidiaries in China reveal a lower degree of local R&D activities compared to the other two market heavy-weights, India and Brazil. Chinese subsidiaries exhibit a higher dependency on technologies that were developed by other units in the MNE network. This finding might be attributed to difficulties of finding, attracting, and retaining qualified personnel for innovation tasks, intellectual property and contract enforcement issues, and the predominance of manufacturing activities in in China. Russia stands out for its high share of Implementation, which is significantly more pronounced than in any

other of the investigated countries. The corresponding low degree of localized R&D might be ascribed to unfavorable factor conditions and high investment hurdles.

Industry differences in R&D configuration were found to be less salient. Subsidiaries in the pharmaceutical industry exhibited a significantly smaller degree of Implementation, suggesting that pharmaceutical companies perform more R&D locally in emerging economies compared to the other manufacturing industries. This situation is reflected in the industry's highest share of Local Innovation and Global Innovation, revealing both a perceived need for the development of local products and a high degree of subsidiary level innovativeness. The share of Global Innovation was found to be significantly lower for subsidiaries in mechanical engineering, which might be because of a predominant technology base in the home country. Subsidiaries that belong to large MNEs that have international experience are more closely integrated in the global innovation network, exhibiting more cross-border interdependencies with other R&D units. This structure allows the MNEs to benefit both from advantageous host country factor conditions and economies of scale. Older and larger subsidiaries show a significantly lower share of Implementation, primarily in favor of Local Innovation but also in favor of Global Innovation. This finding indicates that subsidiaries established less recently and subsidiaries that are more important in the MNE network in terms of employees and turnover are less dependent on technological input from the rest of the MNE. Instead, they revert to their own R&D competencies, primarily developing products for the local subsidiary and secondarily undertaking innovation activities for other units of the MNE network.

Regarding the development of subsidiary R&D configuration in emerging economies over time, the results revealed a significant expected increase of Global Innovation at the cost of Implementation, indicating a clear trend away from the traditional adaptation and support activities and toward more substantive subsidiary R&D activities, with international responsibilities and contributions to the MNEs' innovation networks.

Research question 2: a) How do location factors relate to the choice of international R&D configuration in emerging countries?
b) How do industry factors relate to the choice of international R&D configuration in emerging countries?

The core of the present thesis was a comprehensive investigation of motivational factors driving the configuration of subsidiary R&D in emerging countries. The study aimed to shed light on the effects of determinants that were discussed separately in different contexts and related fields and to analyze their actual influence on foreign R&D in an integrated model. For this purpose, the study followed the contingency perspective, which served as an overall frame of reference for an analysis of the interplay between environmental and response variables in the context of foreign subsidiary R&D.

The research framework considered two dimensions of frequently discussed contingencies: location and industry features. Based on extant theoretical and empirical work, this study summarized host country-related features in the three major motives: market opportunities, economies of location, and cultural distance. These motives cover firms' potential benefits from structural advantages of host countries both on the sales market (output) and on the factor market (input), as well as the potential cost associated with their exploitation. For a comprehensive top-down approach, we operationalized market opportunities and economies of location as formative, multi-item, second-order constructs. Moreover, we investigated the effect of the external environment represented by the industry in which the firm competes. After an extensive review of the pertinent studies in the relevant fields, the following industry-related factors were considered in the research framework: technological complexity, technological turbulence, need for customization (local responsiveness), and cost pressure. The features were expected to be relevant for the configuration of MNEs' subsidiary R&D in emerging countries and to favor or disfavor the localization and cross-border integration of innovation activities.

The empirical results of the research framework supported the majority of the hypothesized relationships between the investigated determinants and the three R&D strategies. Of 21 investigated causal relationships, 16 were found to be statistically significant with the expected sign.

Economies of location, technological turbulence, and market opportunities tunred out to be the most prominent determinants of subsidiary R&D configuration. The results clearly indicated that the exploitation of favorable host country factor conditions represents a major motive for the localization of R&D activities in emerging countries. This finding is the more remarkable because extant literature has mainly emphasized sales market-related motives for the internationalization of R&D and has not shown unequivocal results regarding the motivational effect of host country factor conditions. Regarding the advantages of the host country factor market, factor quality emerged as somewhat more important than factor costs. Yet the results also revealed that spillovers and agglomeration effects, as well as the local supply base, which are generally considered as drivers for the localization of R&D activities, were not yet found to play a role as motive for R&D in emerging countries. This finding might still be explained by the concentration of major, cutting-edge technological know-how in geographically limited centers in developed countries. In addition, the goal of exploiting local market opportunities does not, as it turns out, induce foreign subsidiaries to conduct local-for-local R&D activities on a larger scale; the subsidiaries instead prefer to adapt product and process technologies that have been developed by other MNE units to the local conditions and host country requirements, which requires fewer local innovation resources and capabilities.

Technological turbulence was found to foster configuration strategies that allow for flexibility and that augment the range of available knowledge sources. The results supported expectations that firms facing high industry innovation pressure count on the contribution of foreign R&D units in emerging economies. Monitoring of technological developments is not limited to triad countries but also motivates firms to localize R&D in emerging economies so that they can identify the latest technological

trends and facilitate an effective application of new technologies in the host country.

Cost pressure, which was expected to be a major driver of the localization of R&D in emerging countries, had a relatively modest effect on subsidiary R&D configuration, with only one significant path coefficient. Particularly in the context of emerging economies, this result represented an interesting indication that the relocation of the knowledge-intensive innovation activities does not primarily represent a direct response to industry cost pressures.

Cultural distance proved to be a deterring factor for the localization of R&D activities abroad, showing significant paths toward all three strategies. Despite modern communication and knowledge-sharing technologies, hurdles related to the cross-border transfer and exchange of knowledge with culturally distant countries were thus found to be still existent, yet of relatively subordinate importance compared to the investigated benefits from host country sales and factor markets.

Technological complexity was found to favor specialization accompanied by cross-border integration of innovation activities. Thus, there is no contradiction between technological complexity and the localization of R&D activities in emerging countries. Instead, in sophisticated industrial environments, firms seek to leverage the technological know-how of their foreign subsidiaries for the benefit of the MNEs' global innovation networks.

Regarding the relative influence of the investigated determinants on R&D configuration, it appeared that the Implementation strategy is predominantly motivated by market opportunities while being deterred mainly by technological turbulence and economies of location because of substitutive effects. The Local Innovation strategy is especially driven by the need for local responsiveness, while technological complexity represents the most important deterring factor for this strategy. Finally, Global Innovation turned out to be primarily encouraged by economies of location and technological turbulence; its particular obstacles are the substitutive effects arising from host coun-

try market opportunities.

In terms of the two explored research questions, various contributions to literature have emerged from the present thesis. The conceptual contribution of the thesis stems from the development of an integrated framework that captures existing insights from different related fields in a systematic way, adds new ones, and thus advances our understanding of the motives of MNE subsidiary R&D in emerging countries. The theoretical contribution primarily consists of the integrative approach of the framework. The framework synthesizes determinants of R&D internationalization that have been scattered over various related research fields and investigated separately, often without or with only limited links to foundational theories. Moreover, this work has applied dimensions proposed by IB literature to define subsidiary R&D configuration strategies. The thesis thus provides a bridge between prior research on R&D internationalization and strands of trade theory, FDI theory, and IB theory. Because each theory strand contributes different exploratory factors, the collective, simultaneous consideration of these factors allows a comprehensive perspective with superior insights into and explanations for the effect of environmental features on subsidiary R&D configuration. The empirical contribution of this thesis lies in the various insights offered into both the nature and the motives of foreign R&D in emerging countries. Several putative factors discussed in extant literature were analyzed in an emerging market context. Additional factors and newly hypothesized relationships that have not been covered by previous empirical research could be established and confirmed. Nearly all empirical results were in line with the predictions derived on the basis of sound theoretical, empirical, and conceptual considerations and findings. The results thus provide a meaningful enhancement in understanding subsidiary R&D in emerging economies and a basis for further research in the field.

8.2 Limitations and Implications for Future Research

As does all academic research, the present work comes with limitations, which also represent fertile ground for further research into and on the internationalization of R&D. Moreover, the study's results generate some new, unanswered questions and some blank spots on the map that could profitably be addressed in future investigations.

For the current study, resource interdependencies were measured as the share of R&D provided by, and to, other MNE units (input interdependencies and output interdependencies, respectively). Analyzing in detail the origin and destination of the cross-border knowledge and capability transfer from and to foreign subsidiaries might yield further insights into the interdependencies within MNEs' global innovation networks. For this purpose, it is interesting to distinguish between vertical interdependencies between the foreign subsidiary and corporate headquarters and horizontal interdependencies with other foreign subsidiaries. Moreover, a more detailed examination of the interdependencies that allow for differentiation between different types of international responsibilities (e.g., regional or world mandates) could provide additional insights into the geographical scope of international linkages within MNEs' innovation network.

The present analysis was limited to direct cross-border interdependencies of subsidiary R&D with other parts of the MNE network. "Indirect" linkages, with local R&D know-how being embodied in exported products from a local manufacturing plant, have not been considered. Further research may take this issue into account by considering the interrelations between R&D and the configuration of the downstream functions of manufacturing and sales.

In terms of ownership, the study has focused on firm internal R&D in wholly or majority-owned subsidiaries. Future research can extend subsidiary R&D configuration by

adding ”externalization” as a third configurative dimension (see Jarillo and Martinez 1991). Doing so results in three additional R&D strategies representing the equivalents to Implementation, Local Innovation, and Global Innovation outside firm boundaries. Regarding the theorectical foundation, the evolutionary view, with a focus on the transfer mode of knowledge and capabilities, represents a promising approach for further analyses, considering also the effect of internalization advantages on R&D configuration.

This present work has considered R&D configuration as a free combination of three R&D strategies. Unlike prior R&D typologies, the developed strategies allowed for measurement of gradual differences between and gradual changes in the configuration. Future research could further extend the response variables of the framework by explicitly differentiating between the probability of assigning R&D responsibilities to a foreign subsidiary and the extent of subsidiary R&D. This aspect was indeed implicitly covered by the applied configuration in that the configuration allows for “pure” strategies, with the share of one of the three strategies accounting for 100%. However, an explicit consideration of incidence and intensity of subsidiary R&D in a two-stage mode, accounting for the probability and extent of local R&D, can lead to additional insights into how location-based and industry-based features affect the foreign configuration of innovation activities in emerging countries.

Furthermore, the study at hand did not consider performance effects of subsidiary R&D configuration. The contingency perspective assumes that strategies are not equally effective under all conditions. A fit between the environmental features and R&D configuration is thus expected to determine the organizational performance. Future studies in this direction can further extend the understanding of the performance of subsidiary R&D in emerging economies, which would contribute additional power and meaning to the results.

The framework could also be extended in terms of the explanatory variables. The examined environmental aspects are not exhaustive. Future studies can, for instance,

explore further the effect of the host country institutional environment on foreign R&D. Peng (2008) differentiates between political, legal, social/societal, economic, and cultural institutions. The economic and some of the social aspects have been covered in this study in the context of market opportunities and economies of locations; cultural aspects have been considered as cultural distance. Further research could use an institution-based perspective and, for example, include the effects of host countries' political and legal institutions on the configuration of foreign R&D. The vibrant and fast-changing institutional environment in the leading emerging countries provides a very suitable context to investigate this issue. Relying on subsidiary-level evaluations of local institutions might allow for a deeper understanding of the interplay between governmental action and subsidiary R&D.

The market-subsidiary interface represents another exciting avenue for further investigation. Apart from the local environment in which the subsidiary operates, a recent strand of literature on subsidiary strategy has suggested that the extent to which subsidiaries maintain external network links with other companies and institutions and the extent to which they are able to learn from local environments has an influence on subsidiaries' mandate and configuration (Andersson, Björkman, and Forsgren 2005; Cantwell and Mudambi 2005; Mu, Gnyawali, and Hatfield 2007).The study assumed a rational planning of international R&D based on environmental features to explain variations in R&D configuration. The data do not contain information about historic factors of subsidiaries, such as whether they originate from greenfield investments or from mergers and acquisitions (e.g., Gassmann and Zedtwitz 1999; Zander 1999). Future research can provide deeper insights into the path dependencies of R&D configuration in emerging economies.

Relating to the contents of research, the present study showed some interesting findings and issues that might be subject to and benefit from further research. For example, technological complexity was found to be positively related to output interdependencies of emerging country subsidiaries; yet, contrary to expectations, the anaysis revealed no positive effect on input interdependencies. This result is unexpected

for two reasons: First, complexity was assumed to foster specialization and cross-border integration. Second, technologically sophisticated products were expected to be developed predominantly in the industrialized triad countries rather than in emerging economies. One possible explanation might be Kumar's (2001) finding of different industry patterns depending on the MNE's home country. In this regard, the results of the present study imply that German firms follow a pattern rather like that of U.S. MNEs, instead of like that of Japanese MNEs, which tend to concentrate complex R&D activities in the home country and shift only R&D activities that are related to less sophisticated technologies abroad. Yet this approach presents only a first hint and calls for further research and a more detailed examination of the relationship between technological complexity and localization of R&D in emerging countries. In this context, it is worthwile to analyze whether "traditional" theoretical approaches, which assume emerging economies to be less suitable for performing technologically complex R&D, still reflect today's realities (see also Chng and Pangarkar 2000).

Similarly, cost pressure was found not to be a major motive for the localization of R&D activities in emerging economies. The discussion of the results, while providing some possible explanations, also revealed that additional research on the influence of cost pressure on R&D configuration is required. The results of the present study suggest that in this context the interplay between subsidiary R&D, local manufacturing, and central R&D in the home country represents a promising field for further insights and scientific progress.

8.3 Practical Implications

While this thesis primarily aimed to contribute to academic literature on internationalization of R&D, it also provides implications for managers and policy makers, some of which are summarized in the following paragraphs.

Managing the network of globally dispersed innovation activities represents a major

challenge but offers important leverage for the competitiveness of MNEs. This study revealed that, although the majority of R&D activities is still mainly localized in industrialized countries, MNEs in all industries also invest in R&D in the major emerging countries. There is a clear trend toward the localization of additional value creation and a closer integration of subsidiary R&D in the global MNE network. This trend, as it turns out, also holds for complex technologies whose development can no longer be considered a privilege only of the triad countries. These results not only indicate that emerging countries will play a more important role as locations for innovation activities but also underline the importance for MNEs of considering emerging countries in their strategic innovation management. Managers at corporate headquarters thus should be aware of the increasing importance of R&D activivities in emerging country subsidiaries and their potential contribution to the innovation capabilities of the MNE. Highly dynamic expansion of R&D activities is expected, particularly in India and China.

Furthermore, the configuration strategies introduced in this study represent a tool that puts managers in a position to conduct a structured analysis and optimization of their firm's global R&D footprint (Kaufmann and Nursai 2006). The measurability and action orientation of the underlying strategy dimensions ensure the practical applicability of the configuration introduced in this study: Location of value creation and interdependencies with other units of the MNE network can be measured based on generally available company data and are both subject to managerial choice instead of exogenous pressures. The tool allows managers to compare the R&D configuration of different subsidiaries, as well as to track subsidiaries' progess and changes in their strategic posture. It can also be applied for external benchmarking and monitoring of competitors' R&D configuration. The average values of industries and host countries reported in this study provide reference values and might serve as a first basis for further comparative analyses.

The growing share of R&D located in emerging countries is accompanied by an advancing consolidation of MNEs' innovation network and stronger output interdepend-

encies, which implies an increasing concentration of activities in specialized R&D units that have regional or global responsibilites for a certain product or technology. The integration of dispersed subsidiary R&D in innovation networks should receive special management attention because it allows the MNE to leverage factor advantages of different locations and foreign subsidiaries' specific innovation capabilities on a global scale. Contrary to the popular belief that localization of R&D in emerging economies is mainly triggered by factor cost-related aspects, the study revealed that factor quality-related aspects are likewise essential from a subsidiary management perspective. The pharmaceutical industry appears to have a leading role in the integration of emerging country R&D. MNEs from other industries might follow this model and thus benefit from the location advantages of emerging countries while avoiding an unnecessary duplication of R&D activities in different host countries. In some instances it might be wise to diversify development risks by assigning two or more R&D units in different host countries to work in parallel fashion on a certain technology. Nevertheless, corporate managers should be aware of the potential productivity gains arising from a consolidated global innovation network and actively manage their firm's global R&D footprint.

With increases in cross-border knowledge transfer from foreign R&D units to other parts of the MNE network, issues related to cultural differences between countries gain additional relevance. Managers are well-advised to consider ways to overcome the impediments of cultural distance and to ensure the effective and efficient communication and dispersion of technological knowlege within their global MNE network. Providing modern communication infrastructures and intelligent knowledge management systems can support information flows between geographically distant groups. Yet managers also must put forth effort to manage internal social networks across different locations (Herrlich and Kaufmann 2008). While investing in powerful networking technologies and platforms that represent valuable tools to foster the interaction between R&D personnel in different countries, managers also must recognize the value of traditional face-to-face meetings to encourage the development of sustainable personal networks among employees with different cultural backgrounds.

Finally, considering the expansion of subsidiary R&D in emerging economies in conjunction with recent findings on how to coordinate and control foreign R&D units (e.g., Ambos and Ambos 2009a; Asakawa 2001b), it appears commendable to grant subsidiary management more autonomy to enhance the subsidiaries' innovativeness and to allow them to develop distinct capabilities that they can contribute to the MNE network. This autonomy should be well balanced with central planning and optimization of the firm's global R&D footprint. Ideally, subsidiary managers should be directly involved in this process so that the MNE benefits from their deep understanding of the respective host country environment and its innovation potential and to ensure a high level of commitment.

Policy makers in emerging countries must take into account the implications that arise with respect to the nature and motives of subsidiary R&D activities. For a program to attract additional FDI in R&D and promote the country's stock of knowledge and technological development, governments are well advised to address a combination of different factors around the country's national innovation system. First, labor market conditions, regarding both quality and cost of R&D personnel, represent a key factor for the localization of R&D. By investing in the quality and capacity of technical university education, governments can address both issues simultaneously: ensuring the availability of an abundant and trained workforce on the one hand and obviating both a shortage of qualified personnel for R&D activities and, along with that, skyrocketing labor costs, on the other hand. Second, government incentives were found to motivate MNEs to create knowledge-intensive jobs in the host country; in contrast, lower taxes or fewer regulations turned out not to represent essential levers to attract foreign R&D activities. Third, potential spillovers from research clusters or learning effects from local suppliers are not yet strong enough to be considered motives for MNEs' investment in R&D. For governments it might thus be wise to foster the emergence of geographically limited centers of innovation with a highly specialized supply base in a certain technology field or industry. Fourth, the development toward international interdependent R&D units requires stronger international linkages of the local science base. Policy might be used to broaden the national scope of public research

organizations, support the creation of international research networks, and advance the international mobility and experience of its engineers and scientists. Possible measures comprise the expansion of strategic partnerships and research cooperations with foreign universities, the funding of international R&D projects for research insititutions or domestic and foreign firms, and the support of research travels abroad for scientists. Finally, the present study revealed significant differences between industries and countries regarding the share of local R&D. Governments might particularly focus their promotional activities on emphasizing their country's local strengths to expand existing and attract new R&D activities. Moreover, time-based competition and short innovation cycles were shown to be positively associated with localization of R&D activities. Boosting the innovation system in the sectors with short innovation cycles and high innovation pressure might represent a viable strategy to build up distinct location advantages that attract foreign R&D investments.

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